A risk analysis system for evaluating construction contractors by potential creditors

by

John Nicholas BSc (Hons)

Directed by

Dr. G. D. Holt

A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy

University of Wolverhampton

April, 2000

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Signature....John Nicholas......

Date..........JULY 2000........................

Abstract

This thesis investigates the financial business relationship between UK construction materials suppliers (creditors) and contractors (potential debtors). Particularly, the work concentrates upon suppliers' decision to grant credit (or otherwise) and to what level such credit limits should be granted.

A literature review highlighted the inadequacies of, and lack of previous research relating to current creditworthiness evaluation procedures. Based on this, a conceptual model was developed, to assist suppliers in determining if the risk associated with granting credit resulted in a worthwhile gain, or not. Subsequent research into the variables in the conceptual model identified that the decision to grant credit was a complex one, and that a definitive creditworthiness evaluation model could not be constructed within the time and resource constraints of one particular PhD. However, the underlying notion that suppliers had to perceive the risk of granting credit as 'worthwhile' continually occurred throughout the research. Subsequently, a utility model was determined which took into account both creditor and debtor financial characteristics, to evaluate the utility achieved by a supplier from their business interaction with a contractor (potential debtor).

A UK nation-wide survey of suppliers' credit control and debt collection departments' practices was conducted. This emphasised the importance of materials suppliers to the construction industry. Four multivariate discriminant analysis (MDA) models were constructed based on the data resulting from the survey. The MDA models identified which practices of a supplier's credit control department had most influence upon: i) the utility achieved from furnishing a contractor with credit; and ii) from (i) discovered variables needing consideration in the conceptual creditworthiness model. The MDA models were validated by an independent hold-out sample of suppliers' characteristics. The need for better creditworthiness evaluation procedures is emphasised throughout the thesis.

Acknowledgements

This research has been funded on a bursary provided by the School of Engineering and the Built Environment, at the University of Wolverhampton, United Kingdom.

I acknowledge the numerous organisations who have collaborated in this research project and have been willing to offer comment on the numerous concepts and ideas that have evolved from it. Without such input the research would not have been possible. Thank you.

I also acknowledge the following people:

Mum and Dad, who placed the Freudian golden egg.

My little brother, who continually challenged me to think objectively.

Paul Onions, who taught me that a challenge was far more interesting than an easy task.

Gary Holt, my Director of Studies, who inspired, guided and encouraged me throughout this research project.

Phil Harris and Musa Mihsein for their continual encouragement.

However, the biggest thank you must go to Carole, who put up with my numerous mood swings and continued to support me regardless.

I dedicate this work to Carole

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND TO THE RESEARCH

The UK construction industry accounts for approximately ten per cent of UK Gross Domestic Product (GDP) when peripheral inputs such as materials manufacture and supply are considered (Annual Abstract of Statistics, 1998). As there are very few barriers of entry into the industry, the sector's reputation has become synonymous with producing projects in excess of original budget, in poor time and not necessarily to desired specification (Emmerson, 1962; Banwell, 1964; Latham, 1994; Egan, 1998). Since all construction projects incorporate the use of *the four m's* (men[1], money, machinery and materials), so it is evident that business interaction with any organisation associated with the industry, incorporates an element of financial risk.

This thesis specifically considers the risk that construction materials suppliers expose themselves to, when they furnish construction contractors with credit. Materials suppliers are defined as those organisations that supply the industry with construction materials specifically used in the physical construction of structures. Expose themselves they do: in that over seventy per cent of materials are supplied on credit and that materials suppliers exhibit a surprising lack of attention to assessing this

[1] The masculine pronoun is used throughout this thesis as an aphorism only. The role and contribution of women to the industry is acknowledged and promoted throughout this work.

credit risk (Chapter 7). Generally, materials and machinery represent fifty to sixty per cent of most construction projects' total cost (Construction Industry Institute, 1987). Because suppliers are not seen by liquidating organisations or accountants as preferential or secured creditors, then should a contractor default upon repayment (e.g. become insolvent), then the risk that suppliers expose themselves to becomes apparent. Because the majority of construction materials are sold by way of credit facilities furnished by materials suppliers (Chapter 7), one would expect that suppliers utilise 'investigative' methods and procedures that accurately portray if such risk exposure is economically worthwhile. On the contrary, this research has identified that suppliers' present procedures for evaluating contractors' credit risk could be improved upon to say the least (Chapter 3). It is has also been identified that 'academic' methods by which to evaluate an organisations' probability of insolvency are inappropriate for the construction sector (Langford, et al., 1993).

Current methods for attempting to evaluate the risk associated with granting contractors credit are generally ad hoc and bespoke (Chapter 2). Consequently, suppliers tend to compensate for this risk exposure by demanding a modal profit value of 15 per cent or more on turnover, from the materials they sell (Chapter 7). This margin is regardless of the degree of risk that an individual contracting organisation might impose on the supplier. Because the materials supply market is highly competitive, suppliers have to balance desired profit margins, against credit risk; and this in light of the possibility of losing the contractor's trade to another supplier (competitor). Hence, it is evident that there is a need for being able to accurately quantify the risk associated with granting a contractor credit, against which suppliers can make an educated decision whether to grant credit, or not.

The principal benefits of such a 'credit risk assessment' model would be:

i. that suppliers' quantity of bad debt would be reduced;
ii. resulting from (i) the cost of construction materials would reduce, thereby making construction projects less costly, or contractors' turnover more profitable; and
iii. that the less creditworthy, and possibly more dubious (cowboy) contractors, would be prevented from acquiring a potential source of working capital.

It is because of these issues that the research reported in this thesis is beneficial not only to suppliers, but to the construction industry as a whole.

1.2 AIMS AND OBJECTIVES OF THE RESEARCH

The aim of this research was to: **develop a model(s) to evaluate the risk that materials suppliers expose themselves to when they furnish contractors with credit.** Conversely, a tool that was able to quantify such risk could also benefit contractors, by limiting their commitment levels.

In achieving the research aim, the following objectives were also satisfied:

i. to review previous studies of organisational creditworthiness evaluation and debt collection procedures;
ii. to review the current state of knowledge regarding suppliers' credit control and debt collection procedures;

iii. to identify definitively if there is a *real* need for research into contractor creditworthiness evaluation;

iv. to offer an approach to the task of evaluating contractors' creditworthiness;

v. to investigate statistical associations, trends and central tendency within suppliers' present credit control and debt collection practices;

vi. to identify which variables impose (both positively and negatively) upon the utility achieved by suppliers when they furnish credit; and

vii. to disseminate the findings of this research programme to as wide an audience as possible by submitting, and having papers refereed by other experts with a view to being published in leading academic journals and practitioners' publications.

1.3 RESEARCH METHODOLOGY

A comprehensive literature review was first undertaken, to induct the research. From this review, three main points were soon identified:

i. that very little previous research had been carried out in the domain of evaluating a potential construction debtor;

ii. that present methods for evaluating an organisation's creditworthiness tend to be ad hoc, bespoke and reactive; and

iii. that previous research in this general 'domain' had concentrated on predicting whether a contracting organisation would become insolvent in the near future, rather than how much risk that a contractor may impose upon any organisation furnishing them financial credit.

Because of points (i) to (iii), much of the early research work had to start at an elemental level; that is, basic concepts were applied to the problem in hand. A national survey of UK suppliers' credit control and debt collection procedures was then undertaken to reinforce (or otherwise) the findings of the literature review and to identify which methods suppliers presently used for evaluating potential debtors' creditworthiness and the perceived extent of their effectiveness.

Based on the findings of the research up to this point (i.e. early literature review and UK national survey), it became evident that a model was needed able to consider the supplier / contractor relationship in more detail than did present methods. Derivation of the model was based on systems theory of gestalt and holism. *Gestalt* being defined as the structure being perceived as a whole and not merely as the sum of the parts; whilst *holism* is the whole being greater than the sum of the parts (Kast and Rosenzweig, 1985). Having identified five key 'generic' variables for inclusion in the model (these being [1] contractor's financial characteristics; [2] external economic climate and associated bankruptcy levels; [3] contractor's managerial decision making influences and business morals; [4] the debt collection efficiency of the supplier and amount of credit allowed; and [5] the error correction term for the model), research was subsequently conducted into each of these aspects.

When investigating these variables it became evident that the research was generating more questions than it was answering, and that the notion of developing a 'single' or definitive creditworthiness evaluation model in the time span of one PhD programme was implausible. Whilst this statement may seem very 'negative' at face-value, it serves to justify the need for this research. Such was the lack of previous work in this specific field. For instance, current credit limit methodologies did not consider the lending institute's financial characteristics, and therefore implied that a contractor afforded credit imposed an equal degree of risk onto a crediting organisation, regardless of the size of supplier's financial turnover or profit levels. Present methods of creditworthiness evaluation also failed to explicitly consider the potential debtor's business morals regarding repayment of goods on credit. However, the research continued on the basis that it was evident that the industry would benefit from any findings regarding the problem of evaluating potential debtors' creditworthiness.

Reviews of the research findings were periodically and regularly compiled. The purpose of these reviews was to ensure that the work was not 'widening' into too greater an area and, so that strategic decisions could be made regarding the future direction of the research. These interim reviews formed the basis of 11 papers that were produced, not least, for the purposes of dissemination (refer to point viii; research objectives).

At 12 months into the planned three-year programme, a decision was made to concentrate upon evaluating present methods and practices of credit control and debt collection - that impact upon suppliers' utility. This decision was made as feedback from the academic paper reviewing process occurred, and a conference presentation had indicated to the author a particular interest in this specific aspect of the research. Essentially, the work had produced a model, which for the first time could predict (quantify) the risk to an individual supplier resulting from furnishing a contractor with credit; this was a break through as no other model had ever achieved this previously. By using multivariate discriminant analysis a number of algorithmic models were subsequently constructed to better understand the characteristics of suppliers' - identified as being important influences in the utility experienced by them - when furnishing credit.

1.4 RESEARCH ACHIEVEMENTS

During the period of this research, an interim summary of the research findings was disseminated to suppliers who participated in the survey (A copy of this summary report is provided in Appendix 6.4). Two articles were submitted and accepted for publication in practitioner journals; one conference paper was presented; 10 research papers were produced; and the author became a referee for the *European Journal of Purchasing and Supply Management* and *Logistics Information Management*. The titles of these papers (along with a brief description of each) is as follows:

i. *A conceptual risk assessment model for evaluating contractors' creditworthiness* (reviews and critically appraises present methods for evaluating a potential debtor; a conceptual, more accurate, model for such a task is defined based on the holistic nature of the supplier: contractor relationship).

ii. *Construction company insolvency levels: macroeconomic influences* (considers which variables can indicate to suppliers future possible trends in contractor insolvency levels).

iii. *Financial business relationships: a conceptual model for evaluating contractors creditworthiness* (details managerial decision-making, organisational structures, the individual and their perception of risk, the economic buoyancy of the environment and the supplier-:-contractor relationship which influence repayment of debt).

iv. *Contractor financial credit limits; their derivation and implications for materials suppliers* (reviews and critically appraises present methods for defining credit limits and presents a model for identifying the factors which impact upon the utility gain [or loss] by suppliers who furnish credit facilities).

v. *Suppliers' debt collection and contractor creditworthiness evaluation* (a national survey of suppliers' credit control and debt collection procedures are presented, it highlights that the accuracy and effectiveness of present creditworthiness evaluation and debt collection procedures could be improved upon).

vi. *Forecasting materials suppliers' financial turnover* (investigates one of the variables identified in (iv) above. A multivariate discriminant model is constructed to classify suppliers' financial turnover).

vii. *Risk analysis of construction contractors' trade: predicting materials suppliers' target profit margins* (a multivariate discriminant model is constructed to define the average quantity of profit suppliers seek from granting a contractor credit).

viii. *Influences on construction materials suppliers' financial turnover* (a multivariate discriminant model identifies which variables impact upon supplier financial turnover growth, contraction or sterility).

ix. *Materials suppliers: the builders' banker* (highlights the importance of suppliers in the industry and revokes that research associated with granting a contractor credit is sufficiently accurate).

x. *Predicting materials suppliers' bad debt* (a multivariate discriminant model identifies key characteristics associated with the degree of bad debt suppliers' incur).

Complete bibliographical details of these works are provided in the reference section of this thesis.

1.5 ORGANISATION OF THIS THESIS

1.5.1 Chapter 2: Literature review

Here, the reader is introduced to the general and conceptual issues of the research subject. A comprehensive literature review of present methods for evaluating the creditworthiness of potential debtors is presented. These methods are then critically appraised as to their accuracy and ability to be used within the context of the construction industry (i.e. informational demands) and more particularly, the specific research problem. The key findings in this chapter are:

- that previous research had concentrated to a greater extent on prediction of company insolvency rather than creditworthiness;
- that previous research into contractors' creditworthiness had not received a great deal of attention or been implemented in depth; and
- that the methods used by the construction industry for evaluating credit risk tend to be contrived, ad hoc and bespoke.

Essentially, this chapter identifies the need for, and fully justifies the research.

1.5.2 Chapter 3: Suppliers' importance and conceptual model development

This chapter considers the macroeconomic influence that materials suppliers have on the UK construction industry. It identifies that suppliers are key players in the construction process and that through the credit they furnish contractors, suppliers have a potential ability to remove the less scrupulous contractors from gaining an additional form of working capital (i.e. credit).

A conceptual model for evaluating contractors' creditworthiness, based on best practice and caveats associated with present procedures (identified from chapter 2) is constructed. The model takes into consideration the holistic nature of the business relationship between creditor and potential debtor. Variables detailed in the model are:

i. the contractors' financial characteristics (i.e. resources available to pay debt);
ii. the external economic climate which will influence contractor insolvency levels;
iii. the contractors' managerial and decision-making influences (business morals) regarding payment of debt;
iv. the efficiency of suppliers' debt collection department; and
v. an error correction variable.

1.5.3 Chapter 4: The credit risk model: generic variable definitions and detailed investigation of variables *M* and *E*

Having philosophised with respect to key variables that need to be taken into account when evaluating a potential debtor's creditworthiness, this chapter details the variables of the conceptual model outlined in Chapter 3.

The chapter details (in-depth) the decision-making process that influences contractor organisations' repayment of debt. A detailed literature review regarding decision-making helps to mould a conceptual model that portrays organisational decision-making influences (regarding repayment of debt). Following on from this the chapter then concentrates upon macroeconomic prediction of insolvency rates in the construction industry. It is detailed *why* it is important to consider the macroeconomic environment when evaluating risk imposed by contractors (potential debtors) onto crediting organisations (suppliers). A regression model is developed and presented for predicting future contractor insolvency levels. The business economy is an important aspect to consider in any creditworthiness evaluation model, because if the economy is suffering adverse conditions (large numbers of company insolvencies), then it follows that crediting organisations (suppliers) have less chance of a debtor honouring their debt, than if the converse economic environment prevails.

A review of the work and findings in this research programme is then detailed. The review identifies that a strategic decision was required regarding where future research in this PhD should concentrate. Because the research conducted to this point had uncovered numerous possible research avenues that could be followed, a decision was made to concentrate upon the utility experienced by suppliers' when they furnish a contractor with credit. The review (and section 1.3) details *why* this decision was taken.

1.5.4 Chapter 5: Influences on suppliers' utility when furnishing contractors with credit

This chapter investigates variables impacting upon suppliers' perceived utility gain (or loss) when furnishing credit. A review of present credit limit models is included and critically appraised. The chapter presents a utility evaluation model. The model identifies that utility is related to supplier financial turnover; targeted profit margin; probability of bad debt; and quantity of credit furnished a given contractor.

1.5.5 Chapter 6: Survey construction

Details are given of *how* and *why* the survey of UK suppliers' credit control and debt collection procedures was designed and conducted. The survey was necessary to (inter-alia) identify the reliability (or otherwise) of suppliers' methods of calculating contractors' creditworthiness; that may not have been identified from the literature review. Methods of credit control and debt collection preferred (and why) by practitioners are also investigated.

1.5.6 Chapter 7: Survey results analysis

Descriptive inferential statistics are given based on the survey response data obtained. Results support previous findings regarding the accuracy of present creditworthiness evaluation procedures. Indeed, suppliers themselves are found to hold a consensus opinion that present creditworthiness evaluation procedures have a degree of accuracy no greater than 'poor' or 'average'.

1.5.7 Chapter 8: Modelling suppliers' characteristics: financial turnover; turnover movement; profit; and bad debt

From the utility model presented in Chapter 5, greater consideration is given as to *why* supplier turnover is important in terms of granting credit facilities. A multivariate discriminant (classification) model is presented to identify key characteristics of suppliers' credit control and debt collection procedures that impact upon suppliers' financial turnover. The model is able to predict those suppliers with 'large' financial turnover from those who have 'smaller' financial turnovers.

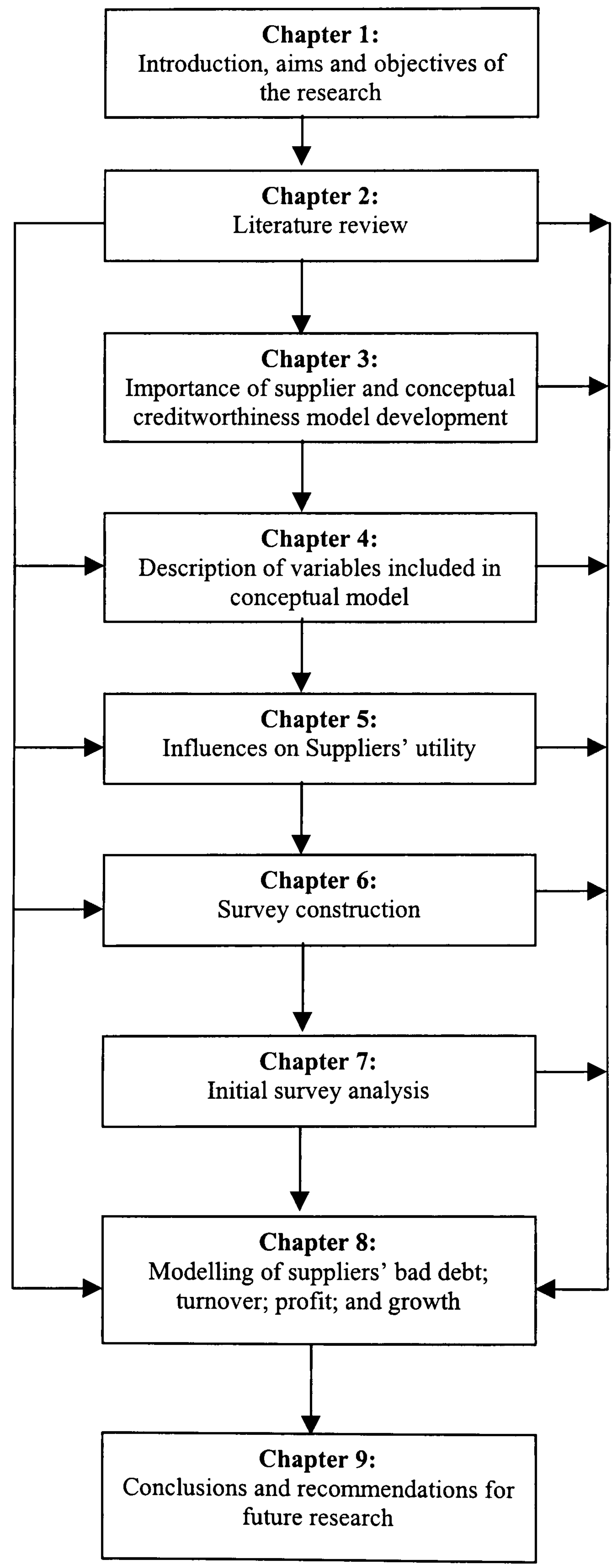
The second section of the chapter describes a multivariate discriminant model to forecast supplier financial turnover movement (e.g. growth or contraction). The third section details a multivariate discriminant model designed to forecast the quantity of bad debt that suppliers' incurred in financial year 1997-8. This time period was specifically used because it was the most recent complete financial year that survey (respondent) suppliers could provide financial figures for, and, that they could accurately detail with respect to their credit control and debt collection procedures used. Finally, a multivariate discriminant model is described, able to forecast the average quantity of profit that suppliers' desire from each credit account they furnish.

1.5.8 Chapter 9: Conclusions, recommendations and future research

The thesis is concluded by highlighting the salient issues and findings uncovered by the research. Conclusions are drawn and recommendations for future research are given.

Essentially, the chapters in this thesis evolve chronologically from the findings of the preceding chapter(s). Hence, the evolvement of the research programme is accurately charted and can be logically followed through to conclusion. The organisation of the thesis is diagrammatically shown in the flow diagram (Figure 1.1).

Figure 1.1
Flow diagram – organisation of thesis



CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter outlines the research subject and presents general and conceptual issues associated with the thesis. A critical review of present methods for analysing risk associated with furnishing credit to construction contractors is detailed. The review highlights flaws in present evaluation procedures and the need for a totally new avenue of research into this subject domain.

The chapter is structured both as a forum for reporting previous research and as a critical review for focusing the aims and objectives for this research project. Both reporting and reviewing procedures are included in this chapter as they complement and allow a general and wide knowledge domain to be built. That is, because many of the following chapters build concepts and models based on previous research, detailed knowledge of previous work is essential.

Discussion concerning the construction industry culture, contractor pre-qualification, contractor failure prediction, cash flow, materials management, decision making, risk analysis and contractor financial characteristics is included to provide a broad base upon which to base future research resources. The nexus of this chapter is that, at present, there is a degree of inaccuracy in the methods presently used for investigating UK construction contractors' creditworthiness. It is found that current methods of analysis fail to consider a plethora of factors which contribute towards classifying the risk suppliers expose themselves to when they grant contractors credit facilities.

Due to the nature of the literature reviewed, some of the work could be categorised under two, or more, of the sub headings used in this chapter. Though this does not occur on a regular basis, it is advised that the whole of the literature review be read in order to achieve maximum understanding from its contents.

2.2 BACKGROUND

The UK construction industry accounts for a significant proportion of UK Gross Domestic Product (Central Statistics Office, 1998). This high volume of trade inevitably carries with it varying degrees of risk to all participants. A significant proportion of this trade is based on credit (Chapter 7), so there is a need for accurate methods of assessing risk for those companies (particularly suppliers) considering business interaction with any other construction organisation. Surprisingly, in terms of suppliers being able to assess potential debtors, this is not the case. Academic research in this subject domain is also scarce. This is the underlying motive for this thesis and the research included within it not only offers benefits for suppliers but also for the construction industry as a whole (Chapter 3). A literature review is now presented to verse the reader with the current status of the topic, to provide a foundation for 'thinking' on the subject and to assist and guide future research (cf. Holt, 1998 p.54).

> *'There is probably no more neglected area of financial management in the UK than credit control and management'* (Kirkman, 1974 p.1)

This was one of the opening statements made regarding the findings of The British Institute of Management's survey concerning credit control and debt collection (Kirkman, 1974). Research to date suggests that certain methods of analysing construction contractors' creditworthiness remains insufficiently detailed and lacks accuracy (Langford, et al., 1993). With such a large component of the country's economic prosperity in its hands, it is reasonable to assume that economic conditions impacting upon construction have been well investigated. Surprisingly, this is not the case. Ofori (1994) stated that:

> *'construction economics, as a field of study is still a fledgling'*

Rutter (1993) shares this opinion and suggested that there is:

> *'something unsatisfactory about economics when applied to the construction industry'*

Hillebrandt's (1974, p.8) work also supported this contention:

> *'The construction industry has characteristics which, separately, are shared by other industries, but in combination appear in construction alone, making it worthy of separate treatment. These characteristics fall into four main groups: the physical nature of the product; the structure*

of the industry together with the organisation of the construction process; the determinants of demand; and the methods of price determination'

The field of financial evaluation and creditworthiness is therefore worthy of ongoing investigation.

Ng, et al. (1999) carried out research into the terms of credit used in various industry sectors. They substantiated the need for their research by identifying that in the 1990's the book value of vendor financing accounted for approximately $1.5 trillion of all assets of U.S. corporations. Ng, et al. reviewed several studies of trade credit and subsequently opted for concentrating their resources upon investigating discounts offered for prompt payment of a debt. To investigate this aspect, a survey was conducted on a broad cross section of industries to identify payment and credit terms utilised. A key result of the survey was that an organisation that furnishes credit, exposes itself to considerable risk. Reputation-based approaches (i.e. duration of relationship) were identified as being far from ideal for quantifying credit risk, but prevalent.

When concentrating upon discounts offered for prompt payment, Ng, et al. identified that organisations (debtors) that failed to take advantage of such benefits incurred financial penalties. Ultimately, Ng, et al. suggested that this inability to make a repayment (to take advantage of a discount) insinuated that the lenders' financial position was questionable (i.e. suggests potential failure). Ng, et al. identified that a minority of respondents (31.8 per cent) indicated they do not permit customers to take unearned discounts.

Buyers and sellers who transacted infrequently were found to be less likely to be well known to each other and their business relationships were likely to be sporadic or seasonal. Though Ng, et al. stated:

> *'Personal relationships between salespeople and their accounts have a lot of influence on sales of our product line'*

Ng, et al.'s research identified that evaluating how a potential debtor acts when furnished credit is important. The method of allowing credit and then monitoring repayment intervals has large risks associated with its technique. Their research, though being helpful in identifying how to monitor an organisation who already has credit, failed to stipulate a method for defining whether to grant credit, or not.

2.3 LITERATURE REVIEW

2.3.1 The UK construction industry culture

The construction industry culture is one of conflict and masculinity (Langford, et al., 1995 p.180). Since suppliers and contractors operate in this environment it is necessary to consider factors influencing their business relationships.

Winch (1998) investigated the growth of self-employment in the British construction industry over the last thirty years. It was identified that proportions of the workforce were increasingly moving towards self-employed status. Further, to some extent, those operatives located in London and the Southeast favoured self-employment more than their counterparts in other UK geographical regions (ibid. p.533-4). The reduced power of Unions in the industry has meant that wages are much easier negotiated and entrepreneurial endeavour encouraged. Since the self-employed rely on 'output' to earn their wages, they tend to be more productive than those operatives who are directly employed (ibid. p.536). Winch (ibid. p.537) asserted that the quality of workmanship tends to be high for the self-employed, as failure to produce quality work results in imminent dismissal. However, the caveat with using self-employed operatives are that they can adopt a 'take the money and run' attitude and, that they very often need close supervision.

Winch's research highlighted the changing employment characteristics of the sector. Consideration of the degree of credit risk a self-employed operative imposes onto suppliers was not discussed in the paper. The observation that the self-employed are more productive than direct employed labour gives a possible indication that the self-employed should have better cash flow than organisations directly employing their workforce *(ceteris paribus)*. Thus, implication and investigation of whether the self-employed have sufficient management morals to honour debts by an agreed date requires research.

Shirazi, et al. (1996) investigated organisational structures in the construction industry. It was shown that the greater the complexity of the environment, the greater the decentralisation of authority. Subsequently, due to construction's dynamic environment, organisational structures had to be adjusted to optimise resource use (ibid. p.199).

Shirazi, et al. (ibid.) identified a number of factors influencing organisational structures. It was proposed that it is necessary to consider both internal and external environmental conditions and adapt the organisation structure to meet the individual demands of construction projects requirements. The main conclusions were that organisation structures are highly dynamic and have to fluctuate to 'balance' with what the environment is 'asking'. As construction projects are generally short term and use multi skilled personnel, it was found that little bureaucracy was needed for organisations to work together effectively. Shirazi, et al.'s work purports that the environment has an influence on business relationships. Research is therefore required to identify what characteristics the environment has on contractor / supplier relationships. This investigation would not only need to consider the economic environment but also the personal attitude that individuals and their organisations have towards their materials suppliers and vice versa.

It is evident that the culture of an industry is important to consider when interacting with any of its participants or organisations. As contractors **have** to purchase materials to construct projects, the relationship between contractor and supplier and the cultural critique needs consideration. For instance, as the construction industry is associated with a hostile culture, could a close and mutually respectful relationship between contractor and supplier lead to reduced credit risk for the supplier and lower materials prices for the contractor? Only future research could answer this question.

2.3.2 Contractor pre-qualification

This section of the literature review concentrates on contractor pre-qualification. Essentially, pre-qualification is a process that contractors should go through to be judged whether they have the ability to undertake a project and complete it to the client's satisfaction.

Holt, et al. (1994; 1995) considered how clients could pre-qualify contractors. Their methodology employed 31 factors, four of which related to the financial characteristics of the contractor. Bank reference and turnover history of the contractor were cited as the most important factors in terms of financial performance. Credit registers were also identified as being important.

Of the 31 factors described in their model, it is evident that the decision of which contractor to appoint is a complex interaction of factors. Inevitably, by considering factors over and above lowest tender price, clients and building users will benefit. In turn, this would result in a more harmonious working culture for the contractor appointed.

Holt, et al. (1994; 1995) incorporated Abidali's (1990) research into a model for evaluating prequalification criteria for contractor selection. It was stated that financial considerations are:

> *'...arguably the most important factors of all those considered'* (Holt, et al., 1995 p.109)

Once again assertions that 'bad' financial ratios are inimically linked with being selected to tender for a project and subsequent organisational survival is emphasised. However, no consideration for analysing the risk that contractors impose on organisations who furnish them with credit was examined.

Chinyio, et al. (1998) presented a methodology for selecting contractors. Their research identified that the varying needs of clients demanded different characteristics from the contractors they could potentially employ. It was found that client categorisation of: public, private or developer was too naïve, subsequently Chinyio, et al. developed a five level client needs-based classification. The purpose of this was to accurately consider clients' particular preferences regarding project flexibility; function; time; maintenance; safety; economy and quality. No other contractor pre-qualification model had considered the characteristics of the client before in this detail. When relating this to contractor creditworthiness evaluation, it is possible to question whether the multitude of characteristics that suppliers and contractors exhibit are compatible when they interact?

Jennnings and Holt (1998) recognised that there had been extensive research into contractor pre-qualification. They subsequently investigated whether there was any association between clients' desires and those perceived by contractors as being important in pre-qualification. Their survey results identified that over one fifth of the sample of large (financial turnover) contractors never had to re-qualify to remain on a clients' standing list and that only 2.80 per cent of contractors were reassessed more than once a year. Over three-quarters of their survey respondents stated that contractors and clients alike would benefit from multi criteria selection of contractors. When considering financial aspects of a contractor and the client / contractor prior business relationship, contractors ranked this as fourth equal from a list of 15 variables. Evidently, for this thesis it is questionable if the characteristics and practices highlighted in Jennings and Holt's research are in some way correlated to the supplier / contractor relationship and suppliers' practices regarding reassessment of contractors' creditworthiness?

Hatush and Skitmore (1997a; 1997b) presented another criteria for contractor selection. It was detailed that the most common criteria during pre-qualification related to contractor financial soundness, stability and information, technical ability, management ability and the contractor's health and safety record. Financial information was defined as ratio analysis, examination of bank references, credit references and turnover history. Financial stability was evaluated by considering credit ratings, bank arrangements, bonding capacity and financial statements. The purpose of financial criteria measurements was to identify any potential future problems that may occur due to contractor capital flow and investment. Again the research concentrated on the risk clients were exposed to when procuring construction works. Again, the risk materials suppliers expose themselves to was not dealt with.

Russell, et al's (1992a) methodology for contractor pre-qualification identified that clients tended to protect themselves from contractor default by demanding that contractors take out bonds (ibid. p.118). Regarding clients pre-qualifying contractors, Russell et al's survey showed similar results to those obtained in Jennings and Holt's (1998) work. Another similarity was observed with Chinyio, et al's (1998) research;

Russell et al. stated that different types of clients (public or private) viewed contractor pre-qualification decision factors differently, whilst construction managers and private owners had similar views regarding pre-qualification (ibid. p.128-9). From this research it is possible to state that there is some form of consensus opinion regarding 'different' clients' attitudes towards pre-qualifying contractors and that different types of relationship demand that various factors be considered to assist in achieving the optimal outcome.

Ng and Smith (1998) described the construction of a pre-qualification system for evaluating contractors. Again, financial aspects were one of five modules considered important for evaluation purposes.

Having reviewed some of the previous research into contractor pre-qualification it is evident that this subject domain has received considerable attention. Much of the work identifies that contractor financial stability and liquidity are important factors; influencing the client decision whether to ask a contractor to tender. It is also evident that the client / contractor relationship is not a simple agenda relying totally upon the lowest tender price. Instead, a plethora of factors need consideration. Undoubtedly, this review highlights that for accurate contractor creditworthiness evaluation purposes, evaluating contractor financial data in isolation will ignore 'other' aspects of the contractor's characteristics that are highly important. For instance, it is also necessary to consider suppliers' characteristics to see if they are amenable with those of the contractor who desires credit.

2.3.3 Contractor failure prediction

As highlighted in the previous section, the ability to predict whether a contractor will 'survive' (for a certain time period) is of paramount importance for clients, sureties and creditors (suppliers) alike. A review of recent research in the subject field of contractor failure prediction is now detailed.

Russell and Zhai (1996) examined the stochastic dynamics of failed (i.e. became insolvent) and non-failed (i.e. continued trading) contractors. By analysing trends and volatility of economic and financial variables, they discovered significant differences between these two groups. They observed the incremental and percentage change of contractors' net worth, gross profit and net working capital. For non-failed contractors these variables remained in a normative state; whilst, up to two years prior to failure, failed companies' results became skewed.

Their work observed the incremental and percentage change of each contractors' net worth, gross profit and net working capital. Using these financial variables it was observed that these variables remained in a normative state for non-failed contractors'; whilst failed companies results for these measures were skewed up to two years prior to a company's failure. Surprisingly, for net-worth, percentage change in gross profit, and net-working capital, two years prior to company failure results were negatively skewed; whilst one year before failure they became positively skewed.

Within the limits detailed by Russell and Zhai (1996, p.191) of their model was the need to incorporate some form of forecasting to predict the value of new construction work in the future. Additionally, they called for the need to incorporate seasonal effects, the quality of cost monitoring (presumably by both the contractor and the client), and the geographical and industrial characteristics of the contractor in any future model created. Evidently, if Russell and Zhai can foresee caveats with practical use of a model to predict failure of a contractor then these implications also need consideration when constructing a contractor creditworthiness evaluation model.

Abidali (1990) utilised ratio analysis as an indicator of construction company solvency. It was found that when three ratios simultaneously exceeded predetermined figures then the organisation had a greater probability of 'failing' than one whose ratios remained above the stated critical levels. The three ratios used were: (i) net assets / current liabilities; (ii) current ratio (defined as current assets / current liabilities); and (iii) pre-tax profits / interest.

Mason and Harris (1979) developed a model for predicting construction contractor failure. Once again, the model identified if a contractor was likely to survive to complete the contract they were tendering for. Their model worked along similar lines to that of Altman's (1968), Bathory's (1987) and Taffler's (1995) models (these three models are discussed later). Mason and Harris's model used multivariate discriminant analysis to identify key financial ratios associated with contractor failure.

Abidali and Harris (1995) presented a methodology for predicting company failure in the construction industry. They employed multivariate discriminant analysis and constructed a Z score model to predict future failure. Variables used in this model were all based on financial ratios. Realising that consideration of financial data in isolation ignores contractors' managerial skills and attitudes, a further model was developed (ibid. p.192). This took into consideration managerial characteristics. It was stated that both financial and management aspects could be used to predict insolvency. The research highlighted that effective contractor management can help a company out of trouble if it deals with the situation correctly (ibid. p.189).

Abidali and Harris did however highlight that caution is required when drawing conclusions about firms in different economic settings than that occurring when they carried out their survey - their survey was undertaken when two percent reduction in UK economic growth was occurring (ibid. p.190). Hence, this research suggests that any creditworthiness evaluation procedure should take into account the prosperity of the economic environment, contractor financial characteristics and their management skills.

Kale and Arditi (1999) investigated whether there was any link between the age of a contractor organisation and their probability of failure. By analysing a group of US contractors over two ten year periods (1973-83 and 1984-94) it was found that when a business starts trading there is little risk of failure, but as time passes the probability of failure increases to a peak risk at 3-4 years old (after initiation). Both periods under investigation showed similar company failure characteristics.

Kale and Arditi suggested that at the start up of a business, the organisation is very sensitive and are 'feeling their way and learning'. As organisations 'learn' they (hopefully) stop making mistakes and therefore incur fewer costs. If the learning process is not sufficiently speedy then errors keep escalating until failure occurs. Hence, management skill and acumen is a factor that has to be considered in organisation failure and any related characteristics imported into a creditworthiness evaluation model.

Severson, et al. (1993) reviewed contractors' accounts to see if there was a similar trend between those contractors who made a surety pay out and those who did not. A more recent publication by Severson, et al. (1994) revealed the same investigation. Severson, et al. (1994) aimed to improve accuracy with which contractors were evaluated in terms of whether they would utilise the sureties contained in a contract bond. It was claimed that ratio analysis is:

> '*subjective and largely dependent on the accumulated experience of the underwriter. Additionally, the interrelationships between these ratios are not thoroughly understood nor have they been quantitatively documented*' (ibid. p.405)

Severson, et al. (ibid. p.406) analysed financial statements of 87 contractors and used trend analysis and hypothesis testing to identify statistically significant differences between claim and non-claim contractors. A claim contractor was defined as one that defaulted on a bond many times, requiring the surety to pay a loss (ibid. p.405); whilst a non-claim contractor was defined as one that did not default on a surety bond. Using a logit function and regression techniques, Severson, et al. (ibid. p.408) suggested that it is possible to differentiate between claim and non-claim contractors using six different financial variables: i. cost monitoring; ii. underbilling; iii. total current liabilities; iv. retained earnings; v. net income before taxes; and vi. sales (ibid. p.410).

Severson, et al. (ibid. p.417) adds to the limitations of the model by detailing the financial ranges that the contractors accounts had to be within to construct the model ($500,000 to $26,000,000 for total assets; $80,000 to $8,300,000 million for net worth; and $1,000,000 to $52,000,000 for sales). Also, Severson, et al. (ibid. p.417) adds that there are factors beyond the contractor's control which need to be considered, such as:

> *'working with owners or designers who are uncooperative, the event of war, or changes in regulations related to construction'*

Whilst some of these limitations are 'acceptable', others remain difficult to accept for the UK construction industry. For instance, Langford, et al. (1995, p.51) stated that:

> *'the trend in employment is increasingly towards small organisations'*

Therefore, it is questionable if Severson, et al.'s model can be used for the UK construction industry if the lower total assets range, based on a exchange rate of 1.62 dollars to the pound (Sunday Times, 1997), is £308,642; the net worth £49,383 and £617,284 for sales.

Evidently, financial trends do portray good predictive signals of potential contractor failure. However, as the economy is highly cyclical in booms and slumps, it is questionable if defining a static limit is accurate and plausible in times of economic volatility. Further, since contractors' accounts are (under normal circumstances) only available after the financial year has ended, it is debatable if (this) out of date data is sufficiently worthwhile for analysing (by suppliers) who furnish contractors with credit on a day-to-day basis. If Severson, et al's work is used in a simple scenario it implies that if a supplier observes certain trends occurring in a contractor's financial data, the contractor should be prevented from having credit. The result of this has two possible outcomes. First, the supplier might be accelerating the date by which the contractor defaults, and second, if the contractor is able to regain good positive cash-flows and the supplier has stopped credit, then the supplier not only loses out on the materials sales during the contractor's 'down' period, but also their business relationship may be adversely affected.

Though the research reviewed does not give a definitive answer to the question of whether a contractor will default or not upon repayment; it does highlight that financial data should be considered in any creditworthiness evaluation model. However, since published accounts are always out of date, it is questionable if significant assertions can be made regarding a contractor's creditworthiness from such documents. Essentially, this section of the review reinforces the difference between evaluation of contractor *survival* and contractor *creditworthiness* evaluation.

2.3.4 Contractor cash flow

Since the preceding section of the literature review identified that lack of sufficient cash flow is linked with potential failure of a contractor, this section of the review considers contractors' cash flow in more detail.

Abdullah and Tyler (1989) identified that cost control systems being utilised by construction companies were accountancy based, giving little consideration to the actual implications for work being carried out on site. This approach subsequently led to cash flow problems. Kaka and Price (1993) investigated cash flow forecasting and control systems for individual construction projects and compared actual cash flow with predicted *S* curve forecasting principles. They identified that the literature concerning cash flow forecasting was inaccurate and in need of re-evaluation (ibid. p.273). Kaka and Price (1991) reviewed present cash flow models and questioned their reliability. It was stated that construction has a large number of bankruptcies. In the main, the final causes of bankruptcies are poor cash flow and failure to convince creditors and lenders that the situation is only temporary.

It was found that cash flow curves tended to fluctuate greatly and appear to be a poor basis upon which to prepare capital expenditure and income forecasts. In light of this finding, Kaka and Price developed a spreadsheet for cash flow prediction. In similar research, Kenley and Wilson (1989) identified that present cash flow models were inaccurate and subsequently developed a model based on the logit transformation of project net cash flow. They stated that the proposed model was useful for the post hoc evaluation of projects' net cash flows. Other research by Skitmore (1992) Tah, et al. (1994) and Kaka (1994) identified the complex nature of predicting project cash flow. Throughout the literature on cash flow prediction the consensus is that a multitude of factors need consideration and these factors encompass a wide spectrum of spheres (e.g. from contractor management skill to prediction of productivity on site). The nexus of these works was that accurate cash flow prediction and control are essential to the survival of a construction contractor. In turn, contractor cash flow problems are likely to manifest themselves in the form of late, or non-payment for goods supplied on credit (Haverstock, Date unknown).

Uff (1991) verifies the importance of cash flow in the construction industry by stating:

> *'cash flow has been referred to by the courts as the life-blood of the industry'*

Latham (1994) also highlighted cash flow as a key problem in the construction sector, recommending that trust funds be set up to ensure security of payment to all parties to a building contract (ibid. section 10.18).

Brett (1991) discussed cash flow as being a factor that was too often forgotten. It was stated:

> *'at a time of trouble in the property market, cash flow becomes far more important than profits'*

Brett (1991a) further contended that 'profit' is:

'merely an accounting concept'

This statement is supported using an example of a company's accounts. The accounts showing a pre-tax profit of £7m, whilst it could (quite easily) have a net cash out flow of minus £2m on its revenue account alone. Clearly, any institution offering credit needs to analyse a proposed debtor's accounts with greatest caution.

Ming, et al. (1996) carried out an historical study from 1910 to 1938 of a building firm in Australia. Their investigation aimed to identify which variables had significantly influenced the profit level of the firm. A number of regression models were constructed. Of these models, two were identified as 'best predictors of profit'. These models found that the condition of the economy, the contract price and contract cost had significant influence over profit levels.

Fellows (1996) used Monte Carlo simulation to forecast subjective costs for construction projects. It was found that the different perceptions of estimators had an influence on tender prices. Since there has to be some form of subjective decision by materials suppliers whether to grant a contractor credit, supplier management perception should explicitly be considered in creditworthiness evaluation.

Navon (1995 and 1996) highlighted the importance of cash flow and stated that if a cash flow management system could identify good control then lending institutes were more likely to lend money than had the converse situation been apparent.

Navon presented a computerised cash flow programme that took into account the different aspects of expenditure on site and subsequent associated cash flows. The programme identified that predicting cash flow was a continuum of complex factors. However, once the task had been completed it could be used as a control and monitoring device.

Punwani (1997) undertook a study of the growth-investment-financing characteristics of major UK construction groups. The work identified that as the economy fluctuated so does financial characteristics of contracting organisations. Also, as the economy evolves, so the organisations operating within it adjust to use the latest techniques and technologies available. Punwani's research highlighted that due to the dynamism of business organisations, different people may be targeting different objectives i.e. organisational growth or profit maximisation. Inevitably these organisation objectives have an influence on the company's cash flow.

Tucker and Rahilly (1988) developed another cash flow model. This model was based on the working day calendar of a project. It was stated that differences of one or two days can have a large influence on cash flow predictions. The caveat with their model was that obtaining information with the accuracy that the model demanded was problematic. Defining exact dates when activities will be completed is practically impossible. This in turn renders inferences from the model relatively unstable.

From this section of the review it is clear that cash flow is important to contractors and suppliers alike. Failure to achieve sufficient cash flow is directly linked with organisational failure. Hence, crediting organisations that perceive a contractor as having poor cash flow control and management should invariably treat them with the highest of caution.

2.3.5 Materials management

Since cash flow has been identified as an important aspect for contractor survival, it follows that variables that impact upon cash flow should be considered. The review now concentrates on materials management for this purpose. This section allows the reader to gain some knowledge into the role of suppliers in the construction industry.

Agapiou, et al. (1998a) highlighted the role of logistics in the materials flow control process. Failure to have the correct materials available in the correct quantity and place, at a predetermined time, results in a loss of productivity on site. When materials are delivered wrongly, delays and costs are incurred. It was stated that in theory control of materials should be a relatively simple task. However, fluctuating demand for construction means that there is a disruptive force imposed on materials supply. This can often lead to supply bottlenecks, which make a planned flow of materials difficult, if not impossible (ibid. p.132).

Agapiou, et al. subsequently presented a materials supply logistic model to ensure materials were received and managed in a correct and timely manner. Throughout this work the importance of suppliers was highlighted in terms of how they can influence projects. However, no consideration was given to how the parties might decide if it was worthwhile for suppliers and contractors to interact commercially.

Wong and Norman (1997) researched the economic impact of materials planning systems for construction projects. It was stated that materials management is worthy of consideration due to poor control inducing unnecessary cost. As the cost of materials can exceed fifty per cent of projects' costs, their importance is high (ibid. p.39) Wong and Norman presented a material planning system for controlling materials flow on construction projects. Though a number of important factors were considered in how to procure materials, no consideration was given regarding which supplier(s) contractors should use, or how to build up a relationship with supplier(s) so that extra leverage could be applied when materials are required, in greater quantities or quicker than normal.

Akintoye (1995) highlighted the importance of stock control for contractors. It was claimed that if accurate inventory measures were used then contractors could gain productivity increases of twelve per cent. Akintoye went on to discuss just-in-time (JIT) inventory control and how this principle could be used to assist contractors in minimising wastage caused by poor materials management. Though JIT does seem an extremely useful tool, Akintoye (ibid. p.105) highlighted potential problems for its use in construction. Essentially, this was described as construction being:

> *'characterised by complex communication and co-ordination environments involving a large number of individuals and interacting fractions'*

Akintoye points out that the use of JIT is not just a materials handling procedure; for JIT to be of maximum efficiency it must permeate into the culture of client, contractor and supplier alike. When fully implemented, JIT is able to assist purchasing of materials by knitting suppliers and contractors together; it also reduces contractors' sourcing procedures; allows a stable environment to be built between supplier and contractor; improves materials delivery; and increases supplier confidence. The comments made by Akintoye imply that a close working relationship is beneficial to supplier and contractor. In such cases both organisations would tend to have a 'good' knowledge of the other, and are therefore be able to make qualitative judgements regarding the amount of risk the other organisation imposes, or may impose onto them. Since this is an important factor influencing a potential creditworthiness model's accuracy, it does highlight that purely financially based accounting models are ignoring this important characteristic.

Tavakoli and Kakalia (1993) developed another materials management system. Their model aimed not only to be beneficial to on-site employees, but also site management and quantity surveyors who submit claims for payment. Once again, the benefits of using such a system are clear, but the initial decision of where to source materials was ignored as well as any associated criteria relating to the supplier / contractor relationship.

Muya, et al. (1997) investigated construction materials supply logistics. The work highlighted that suppliers must be selected to provide the pre-requisite level of customer service. By careful selection of a supplier, it was stated that productivity on site could be improved. This finding in itself was sufficient to warrant industry interest.

Muya, et al. presented an analytical hierarchy approach which aimed to consider the supplier / contractor relationship and assist in the decision making process of selecting a supplier to interact with. The approach took into consideration a number of variables, though explicit consideration of suppliers' credit granting philosophy was not considered. Basically, the work considered the situation from the contractors view point.

Lowe (1987) researched the construction materials supply market for monopolies and oligopolies. The work showed that the construction industry has a large number of contractors operating in it, which are generally run on low capital and employ little mechanisation. Suppliers, on the other hand, are relatively few in number and utilise capital investment modes to benefit from economies of scale and in certain circumstances operate monopolies and oligopolies (ibid. p.57). Lowe went on to consider the environment in which construction work is carried out. It was stated that due to the unstable environment, demand for construction inherently changes. The result of this, it was hypothesised, was that the more creditworthy suppliers could gain competitive advantage as they could adapt their working practices faster and buy in desired services when the need arises (ibid. p.62). The criteria for being defined as 'creditworthy' were not defined.

Regarding suppliers who have a captive market (monopoly), Lowe (ibid. p.66) declared that few firms were able to negotiate discounts from them. However, the larger construction firms who carry out a considerable amount of construction work tend to have more leverage than small firms. This is an important finding for this thesis. For the first time a direct link is made between supplier and contractor. This link implies that for a creditworthiness evaluation model it is necessary not only to consider contractor attributes but also a supplier's characteristics i.e. can the supplier afford the credit the contractor wants and can the supplier afford the risk?

Akintola and Sommerville (1995) reviewed the time lag between clients placing construction orders and work commencing on site. It was identified that when orders for public sector work were placed it takes 11 quarters for it to result in a construction output. Private sector orders take eight quarters. These delays inevitably have an influence on the demand for construction materials. Not only can these findings be used to help suppliers gear themselves for the prevalent future economic environmental conditions (e.g. increase or reduce profit levels to remain competitive) but to also review the tolerable risk that they can withstand.

Since suppliers and contractors have to interact to achieve their business objectives, their relationship has to be considered. The literature reviewed in this section has shown that contractors who fail to manage their materials incur financial penalties in terms of increased handling costs and wastage. The common finding amongst the reviewed literature is that benefits can be gained by both supplier and contractor if they work closely together and have effective communications. The implications of this would be that suppliers would be able to have a 'good' knowledge of their customers and could make qualitative judgements (decisions) about their creditworthiness.

Since the decision to grant credit is complex, the following section of the review considers decision-making.

2.3.6 Decision making

So far the reviewed literature has identified that the personal characteristics and traits of people play a major part in their decision-making processes. Therefore, it would be beneficial to review the literature on this subject.

2.3.6.1 Contractor / Supplier relationships

With increasing demand by clients for employing contractors certified to BS5750 (now ISO 9000), there has inevitably been pressure exerted by contractors onto their suppliers to increase the quality standards of their products and service (Langford, et al., 1995 p.8). Quality in the sense of this chapter incorporates all aspects of performance i.e. minimum rejection rates, guaranteed delivery times and technical support availability for new products etc. Peters and Waterman (1989 p.171) use an example of Caterpillar Tractor (the construction plant manufacturer) to illustrate this:

> *'Caterpillar offers customers forty-eight-hour guaranteed parts delivery service anywhere in the world; if it can't fulfil that promise, the customer gets the parts free'* (ibid.).

The argument throughout this chapter is that the business world is ever changing and in need of constant re-evaluation; to ensure maximum efficiency is being achieved at all times by its participants (see further Handy, 1991).

Increased demand for quality means that all parties to a building contract now have to be carefully selected, to ensure that client dissatisfaction is minimised and hopefully eliminated at all times. Careful selection of an organisation chosen to interact with and their respective quality control inevitably bring with them the need for contractors to work closer with their materials suppliers than used to be the case. On numerous times in the past the construction industry has been stymied with being unable to supply clients with projects on time, to budget, and to the desired quality (Simon, 1942; Emerson, 1962; Banwell, 1964; Latham, 1994). Hence, there *is* a need for removing the risk of utilising materials suppliers that can adversely impact upon customer satisfaction. Extending this further, there is also a need by materials suppliers to minimise the financial risk they expose themselves to, when they furnish credit facilities. Subsequently, there is a need for contractors and suppliers to carefully consider their mutual relationships.

Research by Berggren (1993 p.7) found that the Australian automobile industry was increasingly moving towards single sourcing suppliers, in an attempt to gain greater trust between purchaser and supplier. Burt (1989 pp.127-35) however questions the notion of utilising a single supplier for any purpose other than the purchaser being able to impose greater pressure upon the supplier to meet their requirements. Hence, there *is* evidence to support the contention that organisations are working closer. This greater closeness brings with it pressures for parties to perform better than were they less 'familiar'.

Sako (1992) developed a model for classifying the relationships between customers and suppliers. The model basically consisted of two extreme relationships; at one end was 'Obligation Contractual Relations' (OCR) and at the other 'Arms Length

Relations' (ALR). These relationships reflect the degree of 'trust' between the two trading organisations. This research is detailed in greater depth later in Chapter 4.

2.3.6.2 Relationship development

Considering economic factors alone, (i.e. excluding psychological traits of a supplier wanting to work with a certain contractor, for example, to boost their ego), relationship development between suppliers and contractors is aimed at gaining competitive advantage.

The most extreme 'relationship' is when a customer purchases the supplier's organisation and integrates it into their own. Conversely, the customer may look for the most competitive price from a number of suppliers. This notion reflects the 'make or buy' decision. Jarillo (1995 p.52) gives a cautious note when organisations are considering internally integrating a supplier in order to gain competitive advantage, stating:

> *'This reasoning is not only relatively common but also extremely erroneous and dangerous'*

Jarillo (ibid.) confirmed that companies often forget to consider the increased risk that are being incurred by producing the item for themselves. If this risk were priced, the item would often be as expensive as if purchased externally. Hence, there is sometimes no economic gain in this situation.

The objectives underlying any long-term business relationship, such as that between a customer and supplier, can be summarised as:

i. long-term reliability for service and quality of goods;
ii. competitive advantage gained through economies of scale via joint development of product;
iii. increased management control and greater organisational effectiveness through knowledge of customers' future requirements;
iv. improved organisational image through being seen as innovative and forward looking; and
v. an increased growth in market share via publicity of closer working relationships between the organisations.

Given these five factors, Peters and Waterman (1989 p.156) identified that close working relationships between customers and suppliers do provide advantages for both organisations:

> *'A simple summary of what our research uncovered on the customer attribute is this: the excellent companies really are close to their customers. That's it. Other companies talk about it; the excellent companies do it'*

Inevitably, the development of close working relationships depends largely upon certain environmental and organisational factors. Environment and organisationally related relationship development factors are now discussed.

i. *Duration of relationship*: the longer a relationship exists between organisations the greater the interaction will be. In turn, this results in closer relationships being developed and a certain amount of reliance on each other's performance being expected. Deming (1986) and Sako (1992) analysed the time duration for strategic partnerships to become evident and found that this involved years of close working together, rather than weeks or months. When considering time duration of relationships between construction contractors and materials suppliers, the opportunity to gain such long term relationships (for certain items) is possibly never going to occur. This is due to the individuality of each project requiring certain non-mass produced / unique materials. However, the majority of construction projects require recurrent materials e.g. paint, cement, wood etc. all of which can be single sourced. Hence, there *is* opportunity within construction for certain suppliers and contractors to build closer working relationships over time.

ii. *Specification and delivery criteria*: the more 'bespoke' the item, the greater the chances of interaction among the organisations. This is due to the customer wanting to ensure that the supplier fully understands their needs. In cases where a customer requires a 'standard' item, such as concrete blocks, the opportunity for customer / supplier integration is concentrated more on the price and delivery time of the item, rather than its design. It is possible to conclude that the relationship between a customer and supplier is related to the uniqueness of the item being purchased.

iii. *Culture*: different types of organisation have different cultures. Handy (1993 pp. 180-216) identifies that there are four cultural types: Power, Role, Task and

Person. These four cultural types are detailed later in Chapter 4. It is not unreasonable to suggest that for two different organisations to work together efficiently a cultural match must be present; if cultures oppose each other then conflict will enter the relationship and induce a loss of efficiency.

iv. *Strategy and Leverage*: The longer (time duration) a supplier works for a customer, the greater the demands that customer will impose. Factors such as shorter delivery times, modified specifications to suit customer's needs etc. may all be demanded. Jarillo (1995) developed a model to distinguish different organisational working relationships. By identifying the needs of the customer and the interaction method (negotiation, bidding, selection etc.) it was envisaged that the optimal business relationship method could be identified.

Handy (op. cit.) and Peters (1988) stated that the business environment is constantly evolving; what is perceived as acceptable working practice today may not be acceptable in a few years time. Peters (ibid. p.68) stated:

> *'My unequivocal findings: (1) customers – individual or industrial, high-tech or low, science trained or untrained – will pay a lot for better, and especially best quality; moreover, (2) firms that provide that quality will thrive; (3) workers in all parts of the organisation will become energised by the opportunity to provide top-quality product or service; and (4) no product has a safe quality lead, since new entrants are constantly redefining, for the customer, what is possible'*

From this section of the review, no definitive answer is evident as to how best to develop a business relationship, other than to aim for maximum satisfaction between the two parties and constructing a relationship based on mutual trust. Development of trust is dependent upon many factors, and therefore, to idealise one particular method of developing relationships is impossible due to the profusion of factors to be considered. Hence, there is a need to consider 'other' factors imposing upon relationship development when considering creditworthiness evaluation. The decisions made by debting contractors will inevitably influence the type of relationship they have with their suppliers. This is due to a decision having to be made by the contractor whether to pay on time, within a certain time limit of being invoiced for materials, or wait until a court summons is served. Therefore, the decision making process has to be considered in any model regarding contractor creditworthiness evaluation. The following section of the review considers organisational decision-making.

2.3.6.3 Organisational decision-making

This section of the thesis investigates the psychological aspects of organisational decision-making. By investigating this aspect of human behaviour a greater understanding and appreciation will be gained as to *how* and *why* people react to a situation and the demands imposed upon them. This, when considered in tandem with contractors' creditworthiness evaluation, will help materials suppliers, to understand a possible relationship in a more detailed and accurate manner than is presently the case. The decision-making process is a congruence of many factors and as such, requires great amounts of thought and time spent in order to evaluate a situation correctly.

'Behaviour research' was first considered by Herbert Simon in 1947. So revolutionary was his research that he was awarded the Nobel Prize. Since then research has continued in this area with research and explorations supplying other concepts such as 'boundary' theory and 'group think'. Originating from this research an almost continuous flow of follow-on research has appeared concerning organisational and industrial psychology (Heller, 1976; MacCrimmon and Taylor, 1976). Hence, the subject is now seen, by academics at least, as being of great importance.

The process of decision making is influenced by a multitude of factors. Decisions cannot be considered in isolation. Since human behaviour is involved, the intrinsic nature of the environment, surrounding individuals, culture, political movements, fashion etc. are all factors to be considered.

Decisions are taken by people. The extent to which an individual can influence their surrounding environment is related to the positional power and authority that person has. Decisions are taken to influence the environment in both a strategic and political manner. The degree to which the decision affects the future is subjective to the decision made and has direct influence on the environment. For instance, when the FTSE-100 index was launched in 1984, four of the 100 companies belonged to the construction sector; now there is only one. One could draw the conclusion here that the construction industry is stymied with managers and leaders of less strategic calibre than those in other industries i.e. construction industry companies are led by individuals that have taken decisions less strategically effective than those their counterparts in other industries. However, this conflicts with the fact that the construction industry is a high turnover low profit industry; thus reduction in construction sector representation in the FTSE highlights the increased risk that materials suppliers expose themselves to when offering contractors credit.

Traditional management and decision making theories are based largely on a 'mechanistic' theory, where making decisions is a structured task. Mechanistic theory assumes that:

- the optimal solution can be 'statistically' identified;
- the aim is able to be quantified;
- only one goal is to be achieved;
- a single decision maker pertains; and
- all options are known and understood with certainty.

It is evident that in the context of analysing contractors' creditworthiness this model is far too elementary. It is possible to compare this theory with that of Maslow's hierarchy of needs and 'systems theory'. Maslow's model assumes that once each 'step' is satisfied by the individual, then they automatically strive to satisfy the next stage of need i.e. the model is highly mechanistic (Handy, 1993 p.33). With Systems theory, wider views of all interrelated influences can be observed. Subsequently, although Maslow's model is elementarily useful, Systems theory gives a wider and subjectively greater view of the influencing factors under consideration.

March and Simon (1958) identified that decision-makers are bounded by numerous restrictions. These include limited information, limited cognitive capacity, and resource constraints. Subsequently, these impacts lead to decisions that are often 'satisfactory', rather than 'optimal'. Furthermore, since goals are often broadly (vis-à-vis specifically) defined, the possibility of achieving one hundred per cent satisfaction is significantly reduced from the outset of the decision making process.

Complex decisions require considerable information processing, often by a number of people. In the context of analysing a contractor's creditworthiness it would not be unreasonable for a sales representative, credit control manager, branch manager, and possibly area manager of a materials suppler to be consulted. Group opinion aims to obtain the optimal decision. There are, of course, situations where group opinion has resulted in disastrous results; for instance, the Sydney Opera House had an estimated total cost of $7 million, the final actual cost was $100 million. The purpose of *'group think'*, as termed by Janis (1982; 1985), is to obtain the thoughts of a number of individuals with a 'common' aim in mind (consensus opinion). Hence, the group is normally constructed of those individuals who have common norms, values, notions, upbringings etc. Subsequently, this tends to lead to certain factors, elements of risk, and other issues being overlooked. Since this is possibly the case when suppliers analyse contractors' creditworthiness, it highlights the need for a standardised 'flexible' interview to be held, which would allow investigation into the contractors' motivation calculus and work ethics; this meeting should be attended by as many individuals from each organisation as finances allow. The theory of this interview is understandable, but in practice, it is unlikely for a contractor to communicate information that is prejudicial to their credit needs.

Hambrick and Mason (1984) identified that the environment has a large influence on the effectiveness of managerial decisions. In a situation where turbulence and emergencies are present, Hambrick and Mason (ibid.) identified that heterogeneous teams made more effective decisions than homogeneous groups. As the business economy is prone to booms and slumps there is some form of turbulence present within the environment. Furthermore, since the construction industry has been referred to as:

> *'the barometer of the economy'* (Nash, 1996)

it is possible to conclude that any organisation involved in the industry should be structured towards a heterogeneous team. In being so structured the organisation would optimise their decisions and hence remain in business for a greater time period than compared to a homogeneous organisation; this will especially be the case when a slump occurs in the economy. Therefore, the heterogeneous structured construction contractor would be a better credit risk for materials suppliers than compared to a homogeneous structured contractor.

Fredrickson (1986) contended that structural characteristics of the organisation influence the strategic decision making process. It was identified that formalisation, complexity and centralisation of variables of structure imposed large influences upon decisions. Fredrickson (ibid.) used Mintzberg's (1983) research to highlight the organisational structures that represent the characteristics of better decision making processes; these being: simple structure, machine bureaucracy, and professional bureaucracy. Mintzberg's research is detailed in greater depth in Chapter 4.

From analysing organisational structures, Fredrickson (1986) hypothesised that variation would exist in the decision making process due to differences in organisation structure. The assumption was made that in a formalised machine bureaucracy decisions would be problem and incrementally orientated; centralist, simply structured organisation decisions would be dynamic and innovative whilst complex professional bureaucracy's decisions would be more political. These assumptions were unsupported by research.

Horvarth and McMillan (1979) identified that organisational characteristics impede on the strategic decision making process. Their research identified that positioned power within an organisation had great influences upon the decision making process. Subsequently, opposing Fredrickson's (1986) hypotheses, Horvath and McMillan (1979) discovered that in autocratic organisations decision making was responsive with a more informal approach than occurred in a simply structured organisation.

Shrivastava and Grant (1985) furthermore identified that there was a difference between the type of organisational structure and the decision making process. It was identified that 'managerial autocracy', a proxy for being result-orientated and perspicacious, was far more likely to be found in small organisations. It was highlighted that organisational types had a great influence upon the decision making process.

When analysing the plethora of situational factors that occur, Koopman (1983) identified that rational decisions were influenced by a number of key inputs. These being: mutual trust between the parties; structure for decision making; other individuals involved; and the positional power held by top management involved in the discussion.

Burgelman's (1993) research identified and concluded that strategy and structures were interdependent and interacting parameters. Pool, et al.'s (1986) research supported this conclusion and identified that the power configuration within an organisation was not a fixed item, but a configuration that could be altered and influenced by a number of external factors.

2.3.6.4 Environmental influences

Organisations and the environment within which they operate inevitably influence each other. Research has suggested that in a stable environment bureaucracy flourishes, whilst an alternating environment is more conducive to a flexible structure (Hedberg, et al., 1976). Subsequently, the decision making process is a function of the environment and the organisational structure.

Donaldson and Lorsch (1983) put forward the theory of 'belief systems', in which influencing factors, such as environmental values, strategies, and directional guidance from people in power, all combined to form the organisational strategic norms; in turn influencing the organisation decision making process. Research by Miller, et al. (1988) further highlighted the influences of organisational structure and how this affected the environmental characteristics. Using research by Thompson

(1967), it was found that the main influencing environmental factors on an organisation were: i. customers; ii. suppliers; iii. competitors, and iv. regulatory bodies. Stein (1981) measured how decision making was effected on four magnitudes: i. expansiveness of investigation process; ii. clarity of analysis; iii. thought agility; and iv. group behaviour. It was found that the environment had large influences upon the decision making process; in particular, links were found between environmental complexity and activity analysis, between volatility, changeability and environmental restrictiveness and investigation activity, and between environmental volatility and political activity. Subsequently, it was concluded that there are an infinite number of relationships between organisations and their environment; all of which need to be carefully analysed to evaluate how the decision making process could be influenced.

Miles and Snow (1978) analysed strategic decision-making and proposed that there were fundamentally four types: prospectors, analysers, defenders, and reactors. Each of these typologies has an individual set of characteristics. It was stated that their typology:

> '*...reflects the relationship between managers' perceptions of the environment, the internal power and political structure of the firm and the relationship between strategy, structure and process*'

From Miles and Snow's classification it is possible to question how different strategic decisions (pay on time, pay on receipt of court summons etc.) taken will affect how an organisation reacts to a materials supplier invoicing them for materials supplied. Greater detail of Miles and Snow's research is contained in Chapter 4.

The next question to be answered is this: 'if strategic decisions are either directly, or indirectly linked to the environment that the organisation is operating in, then what are the key influential factor(s) that influence decision makers?' To answer this question it is necessary to investigate perceptions of these influencing factors.

Duncan (1972) asserted that environmental uncertainty is a function of complexity and instability of influencing factors. Anderson and Paine (1975) furthermore highlighted, via analytical research, that perception is a highly individualistic trait; what one person comprehends as being important may be perceived by another as insignificant.

When considering perceptions amongst interrelating organisations, it is necessary to take account of the individual traits of the people involved. This is because individuals in a group should have the same goals and aims as each other if they are to work effectively and efficiently together (Handy, 1993). The individual and different traits of people in the group means that debate will entail regarding the optimum cause of action to be taken to maximise efficiency and minimise waste of resources. Since everyone involved in the decision making process considers their opinion to be correct (Handy, 1993 pp.76-83) debate will commence. The greater the range of individual characteristics, the greater the chances are of obtaining the best decision; simply due to a large number of options being discussed. Conversely, if individuals all have the same opinions and are steeped in their organisation's traditional working procedures no new and innovative decisions will be considered. Subsequently, individual perception has great influences upon the decision making process. Perception is described by Robbins (1991) as:

> *'a process by which individuals organise and interpret their sensory impressions in order to give meaning to their environment'*

Subsequently, it is necessary to consider factors such as: the external environment, fashions and trends in business e.g. late payment, government legislation, the relationship between the organisations etc. Hence, it has to be concluded that when trying to estimate reaction to a situation there is the need to consider a plethora of information. Often this information is unavailable, or seen by the 'estimator' to be of nil, or little importance, which in turn may result in the wrong prognosis.

2.3.6.5 Money

Research regarding the implications of money as a motivator and incentive is vast. However, none of this exploration has concentrated upon payment for goods on credit. Admittedly, there is now a sound knowledge of how to evaluate the 'time value of money' (Pilcher, 1992; Sizer, 1989), but the psychological influences on payment for items on credit has failed to receive appropriate consideration. Subsequently, there is a need to draw hypotheses from research associated with salaries, pay as an incentive and motivator, etc.

Handy (ibid.) stated that pay can infer that the organisation is pleased with the efficiency of a worker i.e. increased pay! In an organisational sense, if by delaying payment for goods an improved profit ratio can be shown to financiers of the (contractor) organisation, then it follows that there is an increased chance of invested money remaining within that company, than compared to an organisation which had performed worse.

Goldberg and Lewis (1979) investigated the implications of money and how people perceived it. It was found that money, for the majority, portrayed security, power, love and freedom. Since it is not uncommon for small organisations' Directors to treat the company bank account as an extension of their own (in the sense that they control how much, where and when money is spent), it is questionable if this statement is true for items purchased on credit.

2.3.6.6 Construction related decision making research

Kometa and Olomolaiye (1997) investigated variables influencing clients' decision to build. It was found that the decision making process encapsulated a number of variables. However, the decision to build predominantly came down to status, prestige, corporate ego, workers' pressure, location and directors' desires.

Goodman and Chinowsky (1997) reviewed the extent of education construction professionals received to undertake executive decisions. Their research showed that due to increased competition in the market place and changing client requirements, construction managers now have to consider a plethora of factors if they are to be successful in their job. By considering the profiles of executives in construction (i.e. if a graduate, how many years have been with the company, age, etc.) a 'toolset' was presented which was intended to benefit construction professionals and universities.

Their paper highlighted that the construction industry is highly dynamic and there is a need for continual reassessment by professionals to see if their company is providing clients with the service that they desire. It also stated that university learning needed to be dynamic to keep abreast of the ever-changing business environment.

Ranasinghe (1996) presented a simplified model for decision-makers to use when predicting the total cost of construction projects. It was shown that the task of estimating project costs had to incorporate a number of variables if the figure was to be accurate. One of the variables considered was inflation; failure to forecast what this would be when the project was being constructed could have dramatic effects on cash flow for all parties of the contract (assuming a fluctuation clause was not included therein).

Decision making research has encapsulated a number of factors. The work has shown that as investigation into one area is carried out it brings to the forefront a similar number of unanswered questions. At present, the reviewed research implies that when suppliers do make a decision to grant a contractor credit they need to evaluate a plethora of factors. Because people perceive different situations in different ways, the ethos that defining a static credit limit becomes an impossible task: some people will perceive the risk as too great, whilst others may not perceive it as significant. This conclusion highlights that creditworthiness needs to consider both supplier and contractor characteristics i.e. is the amount of credit required within the tolerable risk level of the supplier?

2.3.7 Risk analysis

When considering contractor creditworthiness evaluation it is evident that crediting organisations (suppliers) expose themselves to risk when furnishing credit. Because risk is an 'element' against which decisions can be based, a review of risk assessment procedures would possibly assist in development of an accurate creditworthiness evaluation model.

Loosemore (1995) reviewed how construction projects' management dealt with unexpected problems. It was highlighted that as construction projects use temporary organisational structures they invariably, though unintentionally, have to overcome unforeseen problems. This means that when problems do arise there is a need for efficient reactive management decisions and communications. Loosemore's work identified that project members' different behaviour patterns were important factors influencing their problem-solving abilities. With reference to creditworthiness evaluation this research points towards personal issues and characteristics being important variables for both supplier and contractor to consider if maximum mutual benefit is to be achieved by the organisations.

Mak (1995) somewhat contradicted Loosemore's work by stating that due to construction being more complex and technologically advanced than it used to be, risk problems need to be solved in a proactive manner rather than a reactive one. Mak's research described a method of risk analysis that aimed to assist decisions to be made when problems arise on site. Using fuzzy set theory, Mak's risk analysis procedure was shown to work well in assisting construction professionals make decisions for optimal results. Again, this work shows that decisions are highly personal and that a personal view and perception of a situation can be very important.

Uher (1994) presented a general risk classification model for use in construction. The work reviewed a number of risk assessment models and identified caveats with them. From the observations made a risk assessment model was developed. It identified that there are a number of risks that have to be considered when undertaking construction work. By actively looking for future problems in all areas (corporate, project, external / global activity etc.) and taking timely action, the compounded effect of the event can be reduced and possibly eliminated if good risk management is used. In summary, Uher's work implied that proactive risk management had benefits that far outweighed reactive management.

Barr (1996) considered how to communicate information to people. The research concentrated on how to minimise the receivers' rejection of information. It was stated that potentially lots of resources are consumed identifying the best position for siting controversial erections / services (e.g. dumps, electrical pylons etc.) and that failure to communicate effectively with local residents could lead to further expense in having to deal with mass public rejection and objection. Barr conceded however that public perception of the project cannot be quantified in terms of resource consumption, unlike certain other factors. The main finding of the research was that by anticipating public outrage and maintaining two-way communication the probability of incurring *maximum* public outrage is significantly reduced. Relating this to creditworthiness evaluation research, since previously reviewed literature had identified that supplier / contractor trust relationships take time to build, factors which negatively impact upon this business relationship building process need to be reduced. Hence, if a supplier realises that a contractor is exceeding a certain risk limit, then failure to discuss this with them and retain effective communication will prejudice their relationship.

Kometa, et al. (1996) researched the risk clients generated when they employed construction project consultants. It was found that by using their model, client risk could be quantified. Subsequently, risk to consultants in terms of the project overrunning on time and cost, and the project being to the correct specification could be related to the consultation fee charged.

Tiong (1993) identified that clients and sureties incurred significant risk when they interacted with the construction sector. Their research concentrated on guarantees and bonds that clients could ask a contractor to take out for any construction project that they were employed on. Tiong stated that guarantees and bonds are procured to allow the client some form of protection should the contractor default. However, this 'protection' comes at a price, and inevitably increases tender prices: guarantees are a drain on contractors' resources (ibid. p.229).

By considering the relationship between contractor and client, Tiong (ibid. p.241) focused on where the power lies. It was detailed that clients tended to have the prominent proportion of power. Subsequently they demanded that contractors they employed take out guarantees to protect them from potential loss (ibid. p.241).

Tiong's research emphasised the risk clients incur when procuring construction and how they could reduce potential loss by demanding guarantees or bonds to be taken out by the project's contractor. Throughout Tiong's work the emphasis was placed on how clients could protect themselves from loss. It was identified that bonds and guarantees could be used for this task. In terms of relating this to contractor creditworthiness evaluation three observations are made. First, no consideration was given to the parties (suppliers) who supply contractors with quantities of working capital i.e. suppliers' credit risk was ignored. Second, the party that has greatest power tends to be able to make greater (contractual) demands than the less powerful (contractors will utilise this to request better services of their suppliers). Third, that protection from a defaulting organisation comes at a price (protection costs money). Since the economic environment is highly competitive it means that a decision has to be made whether the cost of protection is favourable in relation to the potential benefits it brings.

Ranasinghe and Russell (1992a and 1992b) identified that there was a need to forecast the uncertainty associated with time, cost and revenue. Using cumulative frequency distributions and making a number of assumptions, graphs were produced that represented the probability time duration of a project; its probable cost and probable net present value and internal rate of return. Throughout the work, the emphasis was that that forecasting future events is somewhat reliable on 'luck' as well as 'good judgement'.

The work reviewed in this section identifies that risk in construction is largely related to personal issues, be these either on a macro economic scale or personal one. To evaluate the risk that contractors will impose onto a supplier if they were granted credit demands consideration of these aforementioned issues. Because some topics in need of deliberation are totally out of control of suppliers (like interest rates), subjective qualitative judgements and forecasts have to be made to compensate for this. Personal judgement always has an element of error attached to it, the prediction of contractor creditworthiness will inevitably need to take account of this.

2.3.8 Contractor financial characteristics

This section of the review considers contractor financial characteristics. It is necessary to consider this aspect because contractors can have the good will to honour debts, but if they fail to have the capital for this, then goodwill is worthless.

Fadel and Parkinson (1978) reviewed how ratio analysis could assist in determining the liquidity of an organisation. Their definition of liquidity was return on capital employed. It was found that liquidity directly related to organisational failure or survival. To measure short term liquidity of an organisation three prime methods were used: i. balance sheet ratio analysis; ii. cash generation projections from published accounts; and iii. detailed cash budgets. From ratio observations it was envisaged that comparisons could be made with industry norms. However, the authors recognised that ratio variability does exist between industries and that the measure is static i.e. it does not take account of the current economic climate. In response to this static caveat Beaver (1966) incorporated an element of depreciation into recommended ratio analysis. Depreciation is this sense was defined rather elementarily as net profit plus depreciation. Fadel and Parkinson found that liquidity could best be evaluated by two ratios; these being i. total debt to daily net cash flow; and ii. the ratio of long term debt to daily net cash flow.

Kangari, et al. (1992) studied financial performance evaluation of construction companies. A model was developed incorporating the outputs of six financial ratios; these being summated into a performance index. No accurate method of determining the financial performance of construction companies was found. Subsequently, the model acted solely as an 'early warning indicator' identifying financial 'strength' of a contractor (compared to other companies in the same sector). By predicting financial strength, it was suggested that actions could be taken by lending institutes, bonding companies, investors and clients to minimise their risk exposure.

Kangari, et al. (1992, p.358) admitted that their model had limitations; these being:

i. that the model was only suitable for analysing construction companies being classified into one of the six groups that was detailed in the paper;
ii. the companies to be analysed must be profit seeking and have total assets in the \$100,000 to \$25,000,000 range (based on an exchange rate of \$1.62 to the pound (Times, 1997) this equates to £61,728 to £15,432,098);
iii. the financial ratios of the company must fall into the size-adjusted ratios detailed in the paper. The paper supplies tables for 'size-adjustment ratios' and if the company under consideration fails to be categorised within the limits of these tables then the company cannot be considered any further using their model; and

iv. the performance index, in a range ± 100, has a 1% chance that the index may fall outside the ± 100 range (ibid. p.358).

The model developed by Kangari, et al. (1992) used a number of techniques to analyse financial performance of a contractor. Multiple linear regression of six financial ratios was calculated for each sector of the construction industry. Kangari, et al. (ibid. p.353) then suggested that a 'company size factor' should be applied to those companies' financial ratios that are either smaller or larger than the industry average. Their argument for adjustment in this way was that:

> *'comparing performance of a very small company with the overall industry average is inappropriate'*

If this is the case then any potential creditworthiness model must consider the amount (size) of debt a contractor has the potential to impose onto a supplier.

Kangari, et al. (ibid. p.351) also suggested that the financial performance index grade calculated of contractors was 'for assessing the financial position of a company within the overall construction industry'. Because the business economy is a highly cyclical environment and subject to booms and recessions of varying degrees: Hancock and Gale (1992) described the capitalist system as:

> *'demonstrably <u>not</u> stable or in equilibrium (unless one accepts booms, slumps, crashes, wars and peace time military economies as aspects of dynamic equilibrium)'*

Therefore, the risk to creditors varies according to the economic climate. If this is correct, credit limits must fluctuate to reflect the economic environment and keep the crediting institutes' risk within their perceived level of control.

Severson, et al. (ibid. p.406) added to the Kangari, et al's model limitations by highlighting the fact that the model:

> *'was not validated against any additional contractors' data'*

Langford, et al., (1993) evaluated the accuracy of ratio analysis and Altman's (1968) Z score in predicting company insolvency. By analysing three contractors' accounts who had failed (become insolvent) in the previous five years (1986 - 1991) it was shown that both ratio analysis and the Z score could be used for analysing the financial security of construction companies. However, due to a lack of information regarding construction industry financial 'norms', ratio analysis and Z scores calculated were unable to be compared other than relatively. It was concluded that ratio analysis:

> *'acts as a dipstick of financial health rather than a thorough inspection'*

Whilst the Z score was described as:

> *'a ready basis for evaluation of solvency and performance but cannot unravel the meaning of a company'* (ibid. p.324).

Russell (1992) developed a methodology for analysing and evaluating construction contractors as to whether they were suitable to carry out work on particular projects. Of an eight level hierarchical model, Russell (1992, p.186) classified financial stability of a contractor as one of the elements most commonly analysed when evaluating firms during pre-qualification. Ironically, Russell (1992, p.188) then described the formulae for determining a contractor's financial capabilities as:

'ad hoc'

Russell, et al. (1992a, p.128), in a previous paper, identified that 73 questionnaire items for evaluating contractors at pre-qualification stage had a statistical difference at the 0.05 confidence interval between public owners, private owners and construction managers and their perceived level of importance. However, 'financial stability' and 'financial statement' were two of a total of 18 factors identified as not being statistically different between public and private owners (ibid. p.134). It is therefore possible to deduce that a method of accurately evaluating 'financial stability' and 'financial statement' of a construction contractor would be of great importance to all prospective parties to a building contract.

Russell and Zhai (1996) examined the stochastic dynamics of failed (i.e. became insolvent) and non-failed (i.e. continued trading) contractors. By analysing trends and volatility of economic and financial contractor variables, they discovered significant differences between these two groups of contractors (ibid. p.186-7). A more comprehensive review of this work can be found in the literature review section: Contractor Failure Prediction.

Edum-Fotwe, et al. (1996) reviewed research using financial ratio analysis to predict contractor insolvency. It was found that ratio analysis was a highly useful tool for determining company performance though it does ignore issues such as contractor management skill and acumen and the start-up and failure rates highlighted by Kale and Arditi (1999).

The reviewed literature in this section concentrated predominantly on whether a contractor would survive or fail. There is a significant difference between predicting whether a company will fail and what their degree of creditworthiness is. The reviewed literature tends to ignore creditworthiness evaluation. What can be learned from this section of the literature is that financial ratios are an easily calculated figure that can signify certain trends and characteristics of organisations. The problem with relying on ratio analysis is that its results are always out of date and the accuracy of them is only as reliable as the accounts from which they are based.

2.3.9 General credit management

This section of the review considers literature on general credit management. This section is included because it widens the review to consider financially accountancy based work.

Altman, et al. (1981) presented a comprehensive review of lending institutes methods for evaluating if an organisation was a worthwhile credit risk. Many of the methods reviewed utilised multi-variative discriminant analysis to determine if the potential debtor was a 'good' credit risk, or not. The review identified that many 'credit scoring' techniques used previous years' accounts to evaluate an organisations credit risk. Because previous research has identified that contractors' accounts fluctuate greatly, the notion that the methods described by Altman, et al. are suitable for use in the construction industry is questionable. Further, since the results of the survey of suppliers' credit control and debt collection procedures (described in Chapter 7) identified that suppliers' resources for evaluating a debtor are highly constrained, it is questionable if the methods detailed by Altman, et al. could ever be used by suppliers on a 'mass' usage basis.

Pike and Neale (1999) provided an excellent general overview of corporate finance. They detailed the importance of quality creditworthiness evaluation. On a macro level they estimated that one-third of the assets of UK businesses are in the form of trade debt (ibid. p.389). Pike and Neale suggested possible reasons why organisations offer credit and subsequently placed themselves at risk of incurring bad debt. Reasons detailed were: investment and marketing (possible repeat business); industry and competitive pressures and efficiency (cash on delivery can consume more resources than that consumed by a credit control department).

Pike and Neale realise the difficulty in evaluating a potential debtor and suggest use of the *5 C's* (*C*apacity; *C*haracter; *C*apital; *C*ollateral; *C*onditions) for the task (ibid. p.394). However, details of *how* to physically evaluate a potential debtor using the *5 C's* was not detailed.

A UK national survey of credit control practices was detailed. One of the findings was that only 20 per cent of organisations offered discount for prompt payment; this discount being 2.5 per cent net 30 days (ibid. p.395). Other survey results are detailed in Tables 2.1 and 2.2.

Table 2.1
Trade credit policies in large UK firms

Credit management policy	Percentage of firms having characteristic
Over 90% of sales on credit	81
Credit department structure:	
Separate credit company	6
Centralised	28
Decentralised	66
Normal credit terms:	
Below 30 days	14
30 days net (or end of month following delivery)	52
31-45 days	31
Over 45 days	3
Assign credit limits:	
All customers	68
Selected customers	90
Cash discounts	20
Interest charged on overdue accounts	47

Table 2.2
Credit management practices in large UK firms (145 firms sampled)

Risk screening information services	Percentage of firms having characteristic
Credit agency reports	81
Customers' financial statements	64
Trade references	60
Bank references	48
Competitor trade sources	38
Sales department report	31
Other group companies	32
In-house screening system	16
Risk reduction and financing:	
Credit insurance	38
Retention of title	61
Third party guarantees	31
Factoring without recourse	-
Invoice discounting	5
Use of trade debt to secure borrowings	3
Cash collection:	
Payment in advance	48
Direct debits	29
Sales staff involved in cash collection	68
Debt collection agents	17

The results of the survey are self-explanatory. The interesting overall result is that there is no consensus opinion regarding which technique works best. Instead, industry is shown to use a multitude of techniques for credit control and debt collection.

Smith (1987) considered *why* trade credit is furnished. The work highlighted that cash-on-delivery or cash-before-delivery is not necessarily the cheapest method of trading for the creditor. However, Smith emphasised that furnishing credit induces risk, and this risk has to be controlled and monitored so that it is kept within allowable tolerances. It is suggested that to achieve the monitoring process, the creditor closely observes the repayment characteristics of *all* debtors. By carrying out this process it was envisaged that decisions can be made to reduce bad debt to a minimum. Though the research in this paper is practically useful for building a creditworthiness evaluation model, the initial method for deciding whether to grant credit or not was not detailed.

The Economist published an article in 1998 relating to how Banks evaluate the risk that they are exposed to when they grant credit. The article detailed that Banks set aside enough capital to ensure their survival should a number of debtors default. A number of methods were detailed for evaluating imposed credit risk. However, it was highlighted that the accuracy of the models is largely dependent upon the economic climate. That is, the models' accuracy could only be confirmed after the next recession. Since recessions vary in their characteristics (time length, severity, breadth, etc.) the article suggests that credit risk evaluation models have to be dynamic.

Coleshaw (1989, p.2) hypothesised that there are four distinct stages in analysing creditworthiness, these being:

i. *Appraisal*; the collection of large amounts of information and its subsequent analysis.
ii. *Judgement*; based on the findings of appraisal. Decision as to whether or not to allow the customer credit, and if so how much.
iii. *Monitoring*; analysing the creditor's financial situation on a regular basis and reviewing potential risk to the lending institute.
iv. *Controlling*; the report produced from the monitoring stage will suggest options to retain the creditor's imposed risk within allowable circumstances.

From these four stages Coleshaw (ibid. p.2) suggested that finances borrowed could, in theory, be securely lent under the lender's conceived idea of allowable risk associated with the loan. Rees (1990) recognised the problems with interpreting ratio analysis by highlighting that their interpretation is largely dependent upon the decision-maker's experience. This being due to the dynamic nature of the time-series information and fluctuating market trends (ibid. p.123). However, Rees (ibid. p.403) recognised that any credit evaluation model would inevitably need a degree of 'human information processing'.

Sizer's (1989, p.225) stated that the standards of creditworthiness that institutional lenders use to analyse potential debtors were usually based on financial accounting ratios. However, Coleshaw (1989, p.71) highlighted the fact that the precision of financial ratios is dependent upon the accuracy of the figures inserted into them. In that the only source for these figures is published accounts, the accuracy of ratio analysis has to be questioned. After all, audited accounts are merely 'snapshots' in (previous) time. Stuttaford (1991a, p.60) questioned the accuracy of accounts, and declared:

> *'these* [accounts] *need to be taken with a sack full of salt, and the fact that some well-known firm of chartered accountants has put its name to the audit is worth nothing at all'*

Stuttaford supported this argument with the example of Polly Peck. However, Stuttaford (1991a, p.60) did conceded that:

> *'accounts are useful, as they indicate whether the firm has been growing or declining in turnover, the scale of its operations, whether its profits have been increasing or decreasing and how its fixed assets have changed'*

Russell and Zhai (1996, p.183) identified limitations of using accounts as a basis for future decisions, and proposed that models derived from accounts failed to take account of time-series effects of a firm's financial performance. This highlights the previous 'snapshot' concept. To gauge a contractor's creditworthiness using a set of static measures accounts is wrong. The construction industry is prone to booms and slumps (Hillebrandt, et al., 1995) thus emphasising the need to analyse a contractor's creditworthiness in a holistic manner.

Proponents of credit analysis (Coleshaw, 1989; Briscoe, 1992; Hutson and Butterworth, 1984) suggested that the outputs of calculated ratios be compared with 'norms' published for the given sector of industry, such as those in The Inter Companies Comparisons: Industrial Performance Analysis and publications by Dun and Bradstreet. From these comparisons it was suggested that a credible decision as whether to furnish credit or not, could be made.

When using ratio analysis, in certain cases companies would be considered a 'good risk' on the results of one ratio(s) and a 'bad risk' on results of another(s). Subsequently, the need to evaluate a company in a holistic financial manner (i.e. of all financial account data) was proposed by Altman (1968) and Bathory (1987). By combining a number of key ratios, their results, (this 'aggregated' outcome) indicated whether a company had a reasonable survival risk or not.

Regarding information obtained from Credit Registers; these failed to derive identical credit limits for the same contractor. Variances of 25 per cent have been observed in this respect (Chapter 5). Many credit registers provided information for 'guidance only' and suggested the credit figure be a 'ceiling' amount only. Organisations who acted as insurers and factors for suppliers, reconciled their credit risk by demanding high levels of potential profit.

From published accounts it is possible to calculate a considerable number of different ratios. Coleshaw (1989, p.65) suggested that ratio analysis yields good insight regarding organisation creditworthiness; no definition of creditworthiness was given. A discussion of the principal ratios used for evaluating a company's accounts now follows:

Working Capital: Calculated by the formula:

current assets - current liabilities (ratio 2.1)

Current assets are defined as:

i. *The value of inventory*. A high value may signify slow movement of stock, whilst a low value signals the opposite. However, due to the construction industry being project based (Woodward, 1980) and each project being individual, it becomes questionable if any stock should be held by the contractor, other than the 'tools-of-the-trade'.
ii. *Accounts that owe money to the company.*
iii. *Cash and investments*. Coleshaw (1989, p.67) stated that a low figure shown in the accounts indicates a 'normal' trading position; whilst a high figure can suggest that the investment may be employed in an area that is not conducive to the firms trading activities.
iv. *Prepayments*. For items that require payment after the year end e.g. insurance that runs throughout the year.

Current liabilities are:

> *Short term finances (i.e. $\leq$one year) which are owed to creditors, The Inland Revenue, dividends to be paid to shareholders, overdraft costs, service charges e.g. gas and electricity.*

From ratio 2.1 a positive answer indicates the company has greater current assets than liabilities, and is therefore 'technically solvent'. The greater the figure is, the better the probability of the lending institute being reimbursed should the debtor fail, or become insolvent. A negative answer denotes that the debtor is 'technically insolvent'. However, ratio 2.1 takes no account of long term financial commitments that the firm may have. Subsequently, working capital identifies the present quantity of capital available to the firm in the short term (i.e. $\leq$one year).

Normalised Working Capital: This calculation is used to determine working capital when a full inventory of stock components are unknown. Initially, this lack of information can signify poor book keeping by the company and / or a need to 'hide' certain factors from the published accounts. The formula for normalised working capital is a hybrid evolving from the working capital formula. The percentage factors applied to each formula have been suggested by Bathory (1987).

For service companies:

$$\frac{\textit{Stock}}{100} \times 50 + \textit{All other current assets} - \textit{current liabilities} \qquad \text{(ratio 2.2)}$$

For retailing companies:

$$\frac{Stock}{100} \times 75 + All\ other\ current\ assets - current\ liabilities \qquad \text{(ratio 2.3)}$$

For manufacturing companies:

$$\frac{Stock}{100} \times 25 + All\ other\ current\ assets - current\ liabilities \qquad \text{(ratio 2.4)}$$

As with the working capital formula (ratio 2.1), a positive number signifies the company is technically solvent, whereas a negative number denotes technical insolvency.

The use of these formulae for assessing construction contractors is questionable for two reasons. First, 'stock' is normally kept to a minimum and soon becomes the property of the client after interim payments are made. JCT 80 clause 16 allows unfixed materials and goods intended for the works, whether they are on site or off site to be included in an interim certificate; following payment, the goods and materials will pass into the employer's ownership. Clause 53 of the ICE 6 details that all goods, materials, contractor's equipment temporary works when on site become the property of the employer. Hillebrandt, et al. (1995, p.15-16) highlighted the increased risk of holding stock with an example of land prices, for house building, increasing from £112,000 per hectare in 1981 to £401,000 per hectare in 1994; whilst transactions for new houses dropped by 75% from 1988 to 1991. Second, Fellows (1990) questioned the notion of construction being a single industry. It is therefore possible to suggest that there is a trait of service, manufacturing and retailing in all companies associated with the construction industry. In turn, it is questionable as to which ratio (2.2, 2.3, or 2.4) best represents the construction sector.

Current Ratio: This compares the current assets of a company with their current liabilities and is very closely linked to the calculation of working capital. The formula is:

$$\frac{\textit{Current assets}}{\textit{Current liabilities}} \qquad \text{(ratio 2.5)}$$

For a company to be 'technically' solvent the ratio needs to be greater than 1:1 in favour of current assets.

Liquidity Ratio: The Liquidity ratio, otherwise known as the 'Quick ratio' or 'Acid Test', is a more stringent measure of company liquidity. The flaw in this ratio is that it takes no account of the collection time of debts or the credit terms that a company offers its clients. Goddard and Jay (1980) investigated the effects on different terms of credit and discount given and highlighted that late collection of debts results in reduced profit, and hence greater risk for the lending institute. The formula for Liquidity ratio is:

$$\frac{\textit{Current assets less stock + work in progress}}{\textit{Current liabilities}} \qquad \text{(ratio 2.6)}$$

Coleshaw (1989, p.73) suggested this ratio should be greater than 1:1, but admitted that in practice this is difficult to achieve. Abidali (1990) found little advantage in using the liquidity ratio, (vis-à-vis current ratio) when analysing construction firms; due to stock and work-in-progress soon being transformed into working capital via monthly interim payments.

Normalised Liquidity Ratio: As with normalised working capital, Bathory (1987) suggested a hybrid method of calculating this ratio dependant upon which sector of industry the firm operated in.

For service companies:

$$\frac{\frac{Stock}{100} \times 50 + All\ other\ current\ assets}{Priority\ debt} \qquad \text{(ratio 2.7)}$$

For retailing companies:

$$\frac{\frac{Stock}{100} \times 75 + All\ other\ current\ assets}{Priority\ debt} \qquad \text{(ratio 2.8)}$$

For manufacturing companies:

$$\frac{\frac{Stock}{100} \times 25 + All\ other\ current\ assets}{Priority\ debt} \qquad \text{(ratio 2.9)}$$

Priority debt is defined as that which can be called on first i.e. taxes and banking costs. Subsequently, the term 'secured' or 'preferential creditors' is used for priority debt.

Earlier caveats highlighted for using normalised working capital calculations for construction contractors hold true for the normalised liquidity ratio also.

Ratios (2.1) to (2.9) inclusive have been concerned with the financial standing of the company and their ability to meet credit obligations. Ratios (2.10) to (2.17), which follow, can be used to analyse the efficiency of a company, in terms of how quickly it converts raw materials into cash, the speed at which bills are settled and the proficiency of the business in terms of its financial efficacy. However, these ratios fail to consider the implications of cash flow. Prudent cash flow, as discussed earlier, is the key to continual trading of any company. Subsequently, and once again highlighting the inadequacies of purely accounting based calculations for analysing creditworthiness, is the fact that accounts fail to supply a dynamic and holistic view of a company's cash flow characteristics throughout an accounting period.

Debtors-to-sales ratio: This signifies the time taken to convert debts into a positive cash situation. The figure calculated expresses a static ratio based upon the duration under review. Subsequently, it is questionable if the ratio reflects with accuracy how a company has transformed debt to sales throughout the period. The formula only provides an indication of the average time ratio between debt and sales and fails to take into account any variation in payment times by different debtors. The formula used is:

$$\frac{Debtors}{Sales} \times 100 \qquad \text{(ratio 2.10)}$$

The greater the figure is, the longer (time period) it takes to convert company expense into company income.

Collection period: This ratio complements the debtors-to-sales ratio by defining the number of days taken to convert company expense into company income; the formula used is:

$$\frac{Debtors}{Sales} \times 365 \qquad \text{(ratio 2.11)}$$

The smaller the number the sooner the company transfers cash expense into cash income. This should indicate possible cash flow problems. The restrictions highlighted for the debtors-to-sales ratio hold true for this calculation also.

Creditor ratio: Two formulae can be used, dependant upon what information is available.

$$\frac{\textit{Creditors}}{\textit{Purchases}} \qquad \text{(ratio 2.12)}$$

or

$$\frac{\textit{Creditors}}{\textit{Sales}} \qquad \text{(ratio 2.13)}$$

These formulae indicate proportions of credit against purchases and sales of the company that must be allocated to meet creditor obligations.

Creditor period: This complements analysis for collection period and identifies the number of days' sales required to cover creditors' bills. Ideally, the lower this number is, the better for creditors.

$$\frac{\textit{Creditors Value (£)}}{\textit{Sales Value (£)}} \times 365 \qquad \text{(ratio 2.14)}$$

Stock turnover ratio: Coleshaw (1989, p.74) stated that this ratio is difficult yet useful to calculate. The difficulty arises from interpretation used by accountants as to exactly what stock represents: raw materials; those materials that are presently being used for 'work-in-progress'; and stock which is waiting for dispatch?

$$\frac{\textit{Stock}}{\textit{Sales}} \qquad \text{(ratio 2.15)}$$

The lower the ratio figure then the better, because this indicates a quicker turnover from stocking an item to selling it.

Stock turnover period: This calculates the stock turnover ratio (in days) for the present accounting period. The ratio aims to communicate the efficiency of a firm in terms of its ability to transfer stock into sales. Once again, the static nature of accounts questions the accuracy of whether this ratio represents a true portrayal for the accounting period?

$$\frac{\textit{Stock}}{\textit{Sales}} \times 365 \qquad \text{(ratio 2.16)}$$

Efficiency ratio: This ratio aims to identify how long it takes for a company to convert raw materials into cash i.e. it defines the total length of time from expenditure to income. The shorter the period the better, in cash flow terms.

$$\textit{Stock turnover period} + \textit{collection period} \qquad \text{(ratio 2.17)}$$

The following six formulae analyse company capital structure. Capital structure is defined as: 'the amount of money the company can feasibly utilise in pursuit of future credit and business' (op cit.).

Net worth: This ratio defines the value of a company, taking into account its assets and liabilities. In reality, the value calculated is subject to large fluctuation depending upon the economic climate, the company's present workload and cash flow situation. Subsequently, any credit granted on this ratio alone fails to identify if a company does have financial difficulties; it is possible for net worth not to be realised in total payments to creditors.

Total assets - total liabilities (ratio 2.18)

As with the working capital calculation, the higher the resulting figure then the better for the debtor and the lending institute.

Capital employed: This measures present worth of a company plus the capital consumed at present in long term liabilities (i.e. being used to finance the day-to-day running of the organisation).

Net worth + long term liabilities (ratio 2.19)

Coleshaw (1989, p.76) suggested the greater this figure, the larger the probability of the company being a good credit risk. Hillebrandt, et al.'s (1995, p.40) work supported this conclusion, but highlighted the fact that gearing ratios are prone to change depending upon the prevalent economic climate (ibid. p.38). Hillebrandt, et al. (ibid. p.40) detailed the need for companies to maintain low gearing. The following reasons were given:

- the stock market regards high gearing as high risk; subsequently leading to sharp falls in the values of those companies' shares;

- high gearing denotes high interest costs;
- high gearing means banks become involved in the expenditure and running of the company, who may foreclose on them;
- finance for future projects is more difficult to secure if the company is highly geared; and
- potential clients perceive the company as financially unstable if it is highly geared;
- highly geared companies find greater difficulty in obtaining bonds.

Gearing ratio: This calculates the amount of money a company has borrowed in relation to the net worth of the company. High gearing signifies that a company has borrowed heavily. Subsequently, it is necessary to consider reasons for this high ratio and hence the possibility of a lending institute having its debts honoured by such a firm.

$$\frac{\textit{Current + fixed liabilities}}{\textit{Net worth}} \qquad \text{(ratio 2.20)}$$

Short term gearing ratio: This ratio represents the more imminent (i.e. ≤ 12 months) financial outlays that a company may have. Because short term debts fluctuate more widely than long term debts it gives better representation of the present financial situation of a company seeking credit. When considered jointly with the gearing ratio, it is possible to construct a financial statement of a company's present liabilities to see if they are creditworthy, or not.

$$\frac{\textit{Current liabilities}}{\textit{Net worth}} \qquad \text{(ratio 2.21)}$$

Debt ratio: This defines how a company's assets have been financed i.e. by borrowed money or invested money. The lower this figure is the better.

$$\frac{\textit{Total debt}}{\textit{Total assets}} \qquad \text{(ratio 2.22)}$$

Proprietorship ratio: This ratio considers the amount of money invested by proprietors in a company in comparison to that which has been borrowed. The higher the invested capital by the 'direct financiers' (proprietors) of the company the better; because this signifies that the company investors are prepared to risk their own money to finance the organisation.

$$\frac{\textit{Net worth}}{\textit{Proprietors' investment}} \qquad \text{(ratio 2.23)}$$

The fourth element of analysing a potential debtor is by considering past performance ratios of the company, as calculated from annual audited accounts.

Profit margin: This ratio defines how efficient a company is at making money. May be the higher the ratio, then the 'better' the company is as a credit risk?

$$\frac{\textit{Pre-tax profit}}{\textit{Sales}} \times 100 = (\%) \qquad \text{(ratio 2.24)}$$

It is necessary to carefully analyse this ratio, because too high a profit margin can mean paying excessive taxes. Because company tax is only paid when a profit is made it is quite legitimate to consider reducing the profit margin by making capital investment in new equipment for the company, thus reducing tax liability and maintaining adequate working capital for company re-investment. Furthermore, high profit margins can signify that a firm is operating in an area of business with few competitors, or that the firm has, at present, monopolised the market. Subsequently, it may be necessary to consider future competition in that market place and the effects that this may have on the creditworthiness of the debtor. For instance, Mintzberg (1983) categorised organisations' strategic behaviour into four groups; defenders, prospectors, analysers and reactors. Each of these behaviour patterns has a direct effect upon the macroeconomic environment in which a firm is competing. In turn, any proposed model for predicting future financial stability has to take account of future market competition.

Return on capital employed: This ratio measures the pre-tax profit made by a company in comparison to capital invested in the company. It can be termed as the efficiency ratio of the company and signifies how effectively invested capital has been utilised to produce a profit.

$$\frac{\textit{Pre-tax profit}}{\textit{Capital employed}} \times 100 \qquad \text{(ratio 2.25)}$$

Interest burden ratio: This analyses the cost of loan interest compared to pre-tax profit. The ratio should always be over 100 percent to indicate that company reserves are not being used to financially support the company.

$$\frac{\textit{Pre-tax profit}}{\textit{Interest}} \times 100 = (\%) \qquad \text{(ratio 2.26)}$$

Assets utilisation: The assets utilisation factor makes a crude analysis of how effectively assets are being used.

$$\frac{\textit{Sales}}{\textit{Total assets}} \times 100 \qquad \text{(ratio 2.27)}$$

The following group of ratios are concerned with company growth over the previous accounting period; when compared to current, similar figures. These ratios indicate how effectively the organisation has traded over the previous accounting period and would highlight any trends in output. The theory associated with this group of ratios is that if a company is showing consecutive growth in its published accounts, then creditworthiness of the company is significantly better than one exhibiting contraction (in theory).

Sales growth:

$$\frac{\textit{Sales (previous period)}}{\textit{Sales (current period) - Sales (previous period)}} \times 100 \qquad \text{(ratio 2.28)}$$

Net worth growth:

$$\frac{\textit{Net worth (previous period)}}{\textit{Net worth (current period) - Net worth (previous period)}} \times 100 \qquad \text{(ratio 2.29)}$$

Profit growth:

$$\frac{\textit{Pre-tax profit (previous period)}}{\textit{Pre-tax profit (current period) - Pre-tax profit (previous period)}} \times 100 \qquad \text{(ratio 2.30)}$$

Having presented some formulae for organisational financial ratio analysis, it is evident that there are a multitude of aspects upon which to compare an organisation.

All formulae have valid reasons for use in certain instances. Essentially, formulae outcomes should be compared with the 'norms' of the particular industry. From this comparison it is suggested that credible comparisons can be made. To select key ratios indicating potential organisation failure, research has used multivariate discriminant analysis. This particular research is detailed in the next section of the chapter.

2.3.9.1 Organisation financial analysis models

It can be deduced from the foregone that in certain cases companies will be considered a good risk on the results of one ratio and a bad risk on results of another(s). Subsequently, the need to evaluate a company in a holistic manner of all financial account data has been proposed by Altman (1968) Bathory (1987) and Taffler (1995). Altman, Bathory and Taffler proposed that by using a number of key ratios and summating, or combining in some way their results, this 'aggregated' outcome would indicate if a company was a reasonable credit risk provided it exceeded a certain figure.

Altman's Z score

By using multivariate discriminate analysis (MDA) Altman proposed that a financial measurement of a company's creditworthiness could be established. The Z score is the summation of the following five calculations:

$$\frac{\textit{Working capital}}{\textit{Total assets}} \times 1.2 \qquad \text{(ratio 2.31)}$$

$$\frac{\textit{Retained earnings}}{\textit{Total assets}} \times 1.4 \qquad \text{(ratio 2.32)}$$

$$\frac{\textit{Earnings before tax and interest}}{\textit{Total assets}} \times 3.3 \qquad \text{(ratio 2.33)}$$

$$\frac{\textit{Market value equity}}{\textit{Book debt value}} \times 0.6 \qquad \text{(ratio 2.34)}$$

$$\frac{\textit{Sales}}{\textit{Total assets}} \times 1.0 \qquad \text{(ratio 2.35)}$$

The higher the summation of calculations (2.31) to (2.35) is, the greater the chance of the company not failing. Altman (1976) suggests that a score below 1.81 signifies future bankruptcy; above 2.99 the company is healthy; whilst the cut-off point between a good survival risk firm and bad one, is 2.675. Hence, it can be deduced that the suggested score levels are not linearly, or $\log_{(10)}$ linearly related.

Bathory's Model

Bathory (1987) developed a model that utilised ratio analysis to analyse all sectors of a company's accounts. Like the Z score, the summation of five formulae must exceed a certain figure for the company to be recognised as surviving. The Bathory model is:

$$\frac{\textit{Profit after tax, depreciation and deferred tax}}{\textit{Current debt (bank debt, tax and leasing obligations)}} \qquad \text{(ratio 2.36)}$$

$$\frac{\textit{Pre tax profit}}{\textit{Capital employed}} \qquad \text{(ratio 2.37)}$$

$$\frac{\textit{Equity}}{\textit{Current liabilities}} \qquad \text{(ratio 2.38)}$$

$$\frac{\textit{Tangible net worth}}{\textit{Total liabilities}} \qquad \text{(ratio 2.39)}$$

$\frac{\textit{Working capital}}{\textit{Total assets}}$ (ratio 2.40)

Bathory suggested that a summated score of ratios 2.36 to 2.40 above 0.2 signifies the company has a good probability of survival.

Taffler's Model

Similar to Altman and Bathory's models, Taffler proposed that when the summation of four financial ratios exceeded 0.2 the company had a good long-term survival characteristic. Scores below zero indicated potential failure. The four ratios used are:

$\frac{\textit{Profit before tax}}{\textit{Current liabilities}} \times 0.53$ (ratio 2.41)

$\frac{\textit{Current assets}}{\textit{Total liabilities}} \times 0.13$ (ratio 2.42)

$\frac{\textit{Current liabilities}}{\textit{Total assets}} \times 0.18$ (ratio 2.43)

$\frac{\textit{Turnover}}{\textit{Total assets}} \times 0.16$ (ratio 2.44)

Schwartz (1974) presented an economic model for defining: *why* trade credit was furnished by 'non financially' biased firms (i.e. firms whose **main** task was supplying the market place with services and/or goods other than capital); what differences occur in credit periods between different industry sectors; and how the fluctuating monetary conditions of the economy affect the value of credit furnished. The model used quantitative data to present some complex formulae for answering the above questions. The key findings of the work were: i. list price demand functions tended to be less elastic than present value demand functions; ii. firms which have access to money markets tend to lend to organisations who did not have this access; iii. trade credit undermines the macro monetary control principle; iv. inflation tends to be difficult to estimate for credit purposes; v. because of the result in (iv) credit tends to be restrained or credit periods shortened. In all, Schwartz considered a number of research areas. However, the decision of how to assess whether to grant credit was not answered.

Srinivasan and Kim (1987) carried out a comparative analysis of classification procedures for credit granting purposes. Analysis of present methods for evaluating organisation creditworthiness was presented. However, no suitable alternative to present procedures was suggested.

Edmister (1972) identified that small financial turnover businesses had different characteristics to those of large companies. This was not just in the amount of turnover, but their general financial set-up as a whole. This is an important observation for any future creditworthiness model and combined with the research conducted by Winch into the increased number of self employed in the construction industry, shows that there is a need for discriminating between large and small turnover organisations.

Again, prediction of insolvency was concentrated on; there was no consideration given how to evaluate organisation creditworthiness. All research in this section has concentrated on financial characteristics to predict failure. Because all of the methods in this review claim high predictive accuracy, the use of financial ratios is clear for assisting in the construction of a creditworthiness model. However, which ratios should be used needs research. Further, the method of relating ratio analysis outcomes to the (present) economic climate and the risk suppliers' see as acceptable needs considerable thought.

2.4 LIMITATIONS AND RECOMMENDATIONS STEMMING FROM THE LITERATURE REVIEW

The aim of many financially based models [e.g. Altman's Z-score (1968); Mason and Harris' Z model (1979); Kangari, et al. (1992)] has been to identify whether a contractor will survive through the next accounting period. This is initially beneficial in a study of 'creditworthiness' but fails to identify if a particular contractor has sufficient cash flow and management 'morals' to honour credit. In the USA suppliers are somewhat more protected from bad debtors than their UK counterparts due to the wide use of bonds in the USA and the 1935 Miller Act demanding bonds be taken out for work over the value of $2,000. A bond in this sense is defined as a surety being contractually obliged to honour a contractor's debts should they default (Uff, 1994 p.207). In the UK bonds are not so widely used and only the minority of suppliers tend to insure against bad debt or employ a factor (Chapter 7). Possible reasons for the lack of bond use in the UK are that they tend to be:

> '*...archaic, obscure and full of traps for the uninitiated*' (Murdoch and Hughes, 1996 p.251).

This indicates that suppliers are exposing themselves to potentially high levels of financial risk, and in the majority of cases are failing to employ a 'method' for protecting themselves against debt. This highlights that accurate contractor creditworthiness evaluation should be a high priority for all suppliers furnishing credit facilities.

The ability to accurately evaluate contractors' creditworthiness using financial data is questionable. Amongst their limitations, is the underlying fact that all calculations rely heavily upon past audited accounts. Stuttaford (1991a) questions the quality of such information, and furthermore stated that:

> *'longevity* [of trading] *is no proof of solvency but it does establish some form of track record'.*

If the accuracy of the accounts is questionable, any calculations derived from them will inevitably reflect this degree of uncertainty. With the added knowledge that the majority of suppliers tend to spend less than one hour and no more than £50 evaluating a contractor's creditworthiness (Chapter 7) the notion that such constraints can produce accurate results is questionable. *Information costs money.*

Any model for predicting contractor creditworthiness needs also to contemplate future economic trends and their potential effects upon trade and cash flow. An accurate model will take account of key economic influences. Langford, et al. (1993) highlighted the inadequacies of present financial analysis models by suggesting that, at present:

> *'They* [ratio analysis and Altman's Z-score] *measure a static position and do not account for the dynamism of managerial behaviour in shaping alternative strategies'*

All other models discussed so far have caveats that render them insufficiently accurate for evaluating suppliers' degree of risk exposure from crediting organisations. Finally, not one of these models attempts to quantify the amount of credit that should be furnished. It would seem that this is a function of subjective judgement and experience. Credit registers and Bankers usually recommend a credit limit but these limits fail to recognise the financial risk that a creditor is exposed to (Chapter 5). That is, the quantity of credit recommended for a given contractor is perceived as having an identical risk level for a supplier with a turnover of £½m, as for one with a turnover of £25m. This cannot be correct; creditworthiness evaluation should consider both creditor and debtor 'financial characteristics'.

Business relationships are a complex continuum and need consideration of a multitude of factors (Chapter 4). Since human behaviour cannot be modelled with total accuracy the emphasis is once again placed on the person making the final decision to grant credit, or not.

2.5 SUMMARY

The principal hypothesis of this chapter is that present methods of evaluating potential construction contractor debtors are inaccurate; that they tend to use historical data and subsequently fail to accurately predict a contractor's present financial position.

In the field of analysing construction contractors' creditworthiness, this chapter has highlighted flaws in present methods; mainly due to research concentrating on prediction of *failure* rather than *creditworthiness*. Because the construction industry accounts for such a large amount of the UK's gross domestic product, there demands a method of evaluating contractors as to how financially viable they will be in the future depending upon the booms and slumps that the UK economy is subject to.

At present, there appears no accurate model available for defining the potential future creditworthiness of UK construction contractors. Subsequently, lending institutes rely heavily upon evaluation of past audited accounts as a means of predicting how a contractor is going to perform in the future. Some methods of evaluating creditworthiness have questionable methodology and are ad-hoc in nature, it is debatable therefore if they can accurately reflect the characteristics of the construction industry. Furthermore, the methods purposely designed for evaluating construction companies' financial strength and performance have in the main been based on data from US construction contractors. In that the UK construction industry has different characteristics to the US, the contention that these models will accurately reflect UK construction contractors' characteristics requires substantiation.

A reliable and accurate creditworthiness model needs to be dynamic, be able to evaluate the holistic nature of the economic environment, be based on the most up-to-date financial figures and have an inherent method of predicting the maximum credit limit a contractor should be allowed. Subsequently, the methods detailed in this chapter might be summarised as using 'out-of-date' data and failing to realise the cyclical effects of political and economic changes that the United Kingdom's construction industry is exposed to.

The key findings of this literature review are that contractor creditworthiness evaluation has not received a great deal of previous attention. The methods that are available tend to ignore a large number of important factors (e.g.) such as a contractor's management morals for repayment of debt and the booms and slumps that the UK economy is prone to. Any model devised to analyse credit risk should, undoubtedly, take these factors into consideration if its predictive accuracy is to be high.

The next chapter considers the importance of suppliers to the construction industry. It shows that suppliers are key players in the sector and that **all** methods and procedures used by them for evaluating debtors need to be of the highest accuracy if they are to carry out their role efficiently and effectively. That is, Chapter 3 highlights *why* research into contractor creditworthiness is necessary if suppliers are to prosper and continue to furnish the industry with the credit they do. Because of the inaccuracies within present creditworthiness evaluation methods, a conceptual model is presented to assist in evaluating potential debtors' creditworthiness.

CHAPTER 3

SUPPLIERS' IMPORTANCE AND CONCEPTUAL MODEL DEVELOPMENT

3.1 INTRODUCTION

The literature review presented in the previous chapter identified that little research has been carried out into the importance of the role played by materials suppliers in the construction industry. Because resources in all research fields are finite (Holt, 1998), this chapter asks the question: *'Is there a real need for research into contractor creditworthiness evaluation?'* and, *'Do suppliers play a significant role in the construction industry, such to warrant research resources?'* The chapter aims to answer these questions and thereby justify the potential 'value' of the research contained within this thesis. Building on this justification, a conceptual model for evaluating the risk that suppliers expose themselves to, when they furnish financial credit to contractors, is explained.

The chapter identifies that materials suppliers are indeed important players within the construction industry. That is, not only for the raw materials they market and sell, but also, because they furnish contractors with additional working capital by allowing them materials supplied on credit. Some of those data collected from a UK national survey of materials suppliers' credit control and debt collection practices, carried out as part of this research, is analysed and confirms that suppliers are a vital source of contractors' working capital. These data (i.e. selected for inclusion in this analysis) are concerned with suppliers' financial characteristics and the credit terms they offer contractors (debtors) i.e. turnover, credit sales to turnover ratio, and time duration of credit terms offered (the remainder of this survey data is analysed later in the thesis). It is also apparent from this chapter's analyses that suppliers are critical to the functioning of construction activity. The chapter's observations highlight that through the credit they furnish, suppliers are:

i. exposed to potentially high levels of financial risk;
ii. influence the number of contractors operating in the industry; and
iii. by way of item (ii) have an influence upon tender prices.

In summary, the chapter justifies the real need for this research. From this justification, evidence is produced that demands a model for accurately evaluating the risk associated with granting contractors credit, be developed. The model emanates from caveats identified in the reviewed literature (Chapter 2) and observations of suppliers' present credit control and debt collection practices.

3.2 BACKGROUND

The construction industry contributes significantly to UK GDP (Latham, 1994; Egan, 1998) and is often referred to as 'the barometer of the economy' (Nash, 1996). This axiom has come about due to construction sector participants being highly sensitive to economic influences (Hillebrandt and Cannon, 1994; Hillebrandt, et al., 1995). Insolvencies in the construction industry are twice as more likely than in any other sector (Lowe, 1997a p.84), thus underlying the inherent risks of trading within it. Further, there are very few barriers of entry to the industry (Hillebrandt, 1971; Lowe, 1997a p.87). These facts combined, imply that there is significant risk when interacting (at a business level) with any organisation associated with the sector. One result of this, amongst others, is that construction has earned a reputation for not being able to produce a product able to fully satisfy clients' requirements (Emmerson, 1962; Banwell, 1964; Latham 1994; Egan; 1998) i.e. in terms of project time, cost and quality parameters. This in turn, means that construction has become renowned for (typically contractor / client) conflict, contractual disputes and litigation (Uff, 1994; Murdoch and Hughes, 1996). Indeed, the legal professions are often the principal beneficiaries of construction project delivery.

When considering the relationship between contractors and their (materials) suppliers, it is evident that suppliers are exposed to significant risk when they furnish materials on credit. Survey results indicated that, generally over seventy per cent of suppliers' financial turnover is accounted for by credit sales (Chapter 7). These (supplier) credit facilities underpin construction activity and because of this, suppliers have earned the reputation of being: *'the Builders' Banker'* (Agapiou, 1998b; Lowe, 1997a). From such observations, it is evident that there is a need for accurate creditworthiness evaluation, if suppliers' bad debt is to be minimised and credit risk kept within allowable tolerances. The need for effective supplier credit control and debt collection procedures is therefore clear. Since the observations made in the literature review (Chapter 2) identified flaws in present methods of contractor evaluation, a conceptual creditworthiness model is developed to embrace the holistic nature of the interaction between supplier and potential debtor (contractor). This chapter explores the influences that suppliers have on the industry and its users (clients and customers). The chapter specifically concentrates upon the financial aspects of the contractor / supplier relationship. For the reader who is interested in the 'wider' role of suppliers, they are directed to, amongst others, Muya, et al. (1997); Sandras (1989); and Lowe (1987b).

The methodology employed to investigate the said trading relationship used macroeconomic figures and survey results to quantify the macro-amount of credit furnished by suppliers. A discussion on these findings then follows.

3.3 METHODOLOGY

3.3.1 The survey

As part of this research programme a national UK postal, structured survey of suppliers' (creditors') debt collection and creditworthiness evaluation procedures was conducted in 1998. The main purpose of this survey was to reinforce (or otherwise) the findings of the extensive literature review (provided in Chapter 2), particularly with respect to suppliers' credit control and debt collection procedures. The aspects of the survey concentrated upon in this chapter are those relating to:

i. suppliers' financial turnover;
ii. financial turnover to credit sales ratio; and
iii. the terms of payment offered by suppliers, to debtors (contractors).

The figures obtained from these observations are then related to 1998 UK macro figures associated with construction industry activity. Subsequent analysis provides evidence to support the need for this research. Greater elucidation of the survey design and results of analysis are given in Chapters 6 and 7 respectively of this thesis. Chapter 6 details methodologies considered for obtaining information relating to current industry practice with respect to supplier credit control and debt collection, and, *how* and *which* suppliers were to be targeted for inclusion in the survey sample. Chapter 7 complements Chapter 6, in that the responses to the survey are analysed and observed for trends and practice procedures with respect to suppliers' evaluation of contractors' creditworthiness and debt collection procedures employed.

3.3.2 Data analysis: suppliers' financial turnover, credit sales to turnover ratio and debtors' terms of payment

In 1998 the gross domestic product of the UK was £672.2bn, of which construction contributed £35.1bn (5%) (UK Economic Accounts, 1999). When one considers that between 50 to 60 per cent of the cost of construction projects is represented by materials and equipment (Construction Industry Institute, 1987), it is possible to conservatively estimate that total construction materials sales for the year 1998 were valued at approximately £17.6bn.

Using survey respondent supplied information, the quantity (£) of materials sold by suppliers participating in the survey can be estimated from:

$$\textit{Individual supplier financial turnover} \times \textit{Proportion of credit sales to turnover} = \textit{Individual supplier credit sales} \qquad \text{(Formula 3.1)}$$

From Formula 3.1, individual respondent suppliers' credit sales were summated and compared to the respondents' summated total financial turnover. The sum total of respondents' turnover was estimated at approximately £½bn; of which total credit sales were estimated at £0.4bn. That is, nearly eighty per of materials supplied to the industry was via credit facilities.

From the estimated macro figure of materials sold (£17.6bn) it was possible to calculate that the survey conservatively captured approximately three per cent of all materials sold to the UK construction industry in 1998 (£½bn / £17.6bn). This figure may appear small, but the highest financial turnover category listed in the survey was '£25m and over'. In that some of the respondents (in this turnover category) returned the questionnaire anonymously, an accurate estimation of total survey trade cannot be made by consulting the suppliers' respective published accounts. Some respondents in this category had a turnover well in excess of £25m per year (i.e. they were national household names), so the three per cent figure quoted above is **very** conservative.

It was then possible to estimate the macro-value of materials sold using credit furnished by suppliers, from:

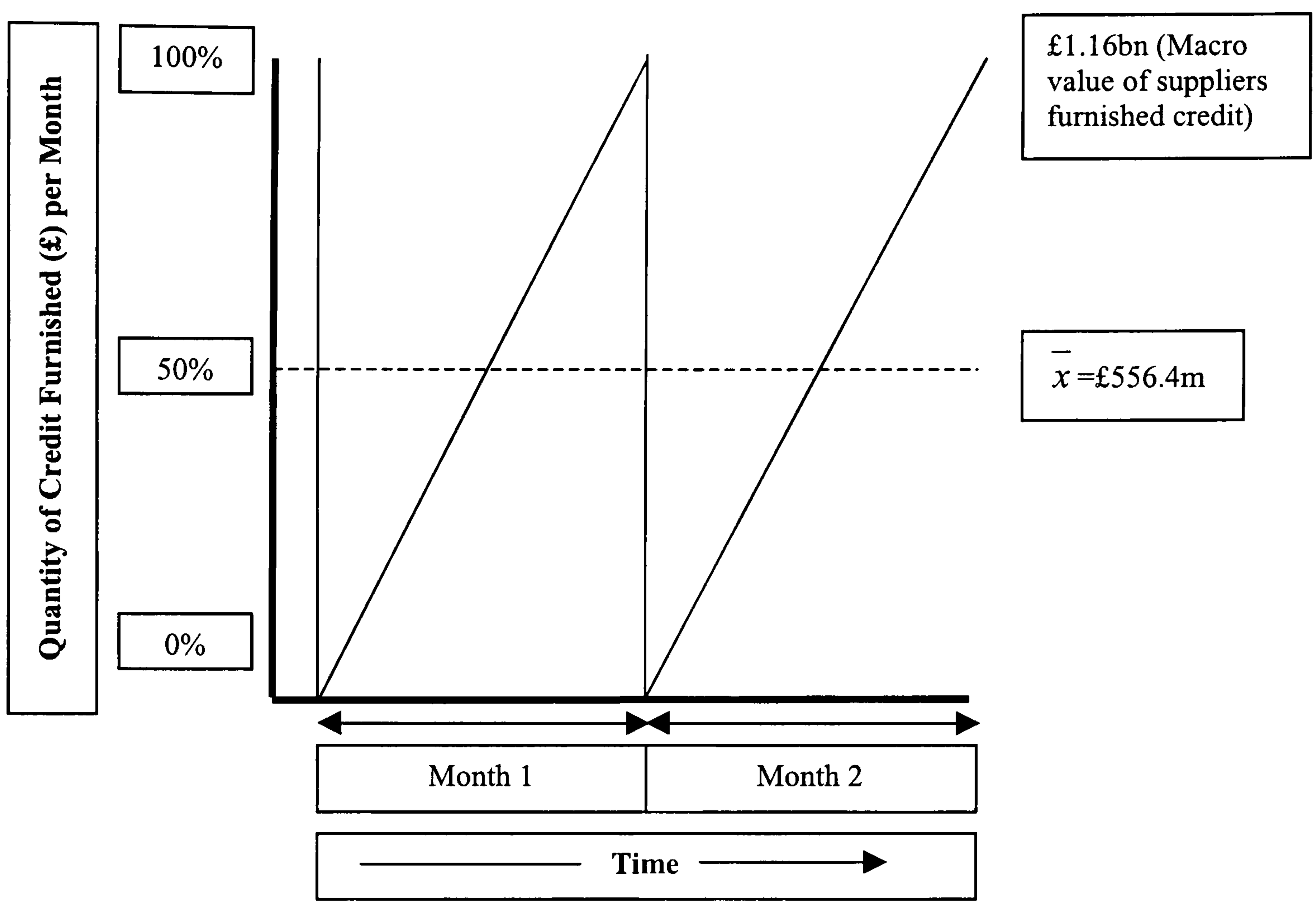
Total (macro) materials sold to construction industry	*x*	*Survey credit sales to turnover ratio*	=	*materials purchased on credit (macro)*	(Formula 3.2)
£17.6bn	*x*	*0.79*	=	*£13.9bn*	

When referring back to the earlier UK GDP figures, credit sales of construction materials therefore represent over two per cent of UK GDP (£13.9bn / £672.2bn = 2.07%).

With regard to the terms of credit that suppliers impose on contractors, the majority of survey respondents (68%) stated that payment should be received by the end of the month after delivery (Chapter 7). If, for the purpose of insight it is (conveniently) assumed that the value of materials purchased throughout the year is constant, then each month, approximately £1.16bn worth of materials are purchased on credit (£13.9bn / 12). Assuming that material deliveries are made for constant values each day of the month, it is possible to manipulate the economic order quantity (EOQ) inventory control model (Drury, 1993). This identifies the extent of suppliers' credit usage by contractors throughout each month (Figure 3.1).

The EOQ inventory control model is used for determining the optimal number of orders, to minimise inventory holding costs and costs of placing orders. The model assumes that contractors receive materials at the exact time the last item of stock is used. Whilst somewhat 'contrived', the method trades off inventory holding costs against the cost of placing orders (Drury, 1993 p.482). Hence, using the EOQ assumption that materials draw is constant throughout the UK each month, UK suppliers' approximate average (total) amount of potential debt is over £½bn per month (£1.16bn / 2).

Figure 3.1
Draw on Suppliers' Credit per Month



If it is now assumed that interest charged on borrowed money is 5¼ per cent per year (Bank of England lending rate at 24 May 1999 [Financial Times, 1999]), it is possible to derive that for each month, interest accrues at a compound rate of 0.4 per cent. Therefore, the total interest charges per month, for all UK suppliers' credit, amounts to £2.3m (£581.5m - £579.2m).

Having presented the 'figures' associated with volume (£) of suppliers' credit and associated costs of interest, a discussion on these findings now follows.

3.4 DISCUSSION

It is evident that suppliers are **very** important players within the sector due to the role they perform and the amount of working capital that they furnish contractors. It is surprising therefore that research into suppliers' traits and characteristics has been sparse, particularly, when compared to the volume of research carried out with respect to evaluating contractors' creditworthiness.

The value (£) of materials sold on credit confirms the need for effective and efficient supplier credit control and debt collection procedures. Particularly, if poor cash flow and bad debt are to be minimised. Previous research in this field has identified that present industry practice could be significantly improved upon (Chapter 2). No (construction) creditworthiness evaluation model was discovered in the literature review, able to consider suppliers' risk with respect to (for example) the quantity of credit a contractor should be allowed. Present methods imply that credit to one contractor imposes an equal (but proportionate) quantity of risk to a supplier with turnover of > £25m as to a supplier with £½m turnover (Chapter 5).

When considering the assertion that suppliers are the Builders' Banker, it is evident that a significant proportion of materials are sold using credit. The figure of more than £2¼m per month in total UK materials interest charges can be defined as suppliers' costs for granting this facility. Conversely, it implies that contractors are 'saving' this amount by using suppliers' credit facilities. This is because they do not have to borrow to this amount from organisations that would make a direct charge for this working capital (i.e. Banks, lending institutes etc.). In turn, this 'contribution' can go towards reducing contractors' overheads, and therefore represents a reduction in cost-estimate mark-up. The credit that suppliers furnish helps ensure that contractors are able to tender for, and subsequently, carry out construction projects well beyond the scope of their own asset base (alone). On a macro level, this contributes some way to keeping more contractors in business and therefore, logically, tender prices to be kept keen (i.e. pressure due to competition).

It may be argued that the cost of borrowed capital is incorporated into suppliers' overheads, which is then applied to the basic cost of materials. Since the majority of suppliers do not fully appreciate the time value of money, as indicated by 62 per cent of suppliers not offering discounts for payment by an agreed date (Chapter 7), this observation gives some indication that suppliers possibly fail to 'charge' for the loan of such credit.

3.4.1 Summary of importance of suppliers

Some of the influences that suppliers have on the construction industry have been identified. It is apparent that suppliers' are indeed the 'Builders' Banker'. Through the credit they furnish, considerable financial assistance (working capital) is given to contractors. Inevitably, furnishing credit in an industry where conflict and insolvencies are abundant, is enthralled with risk, and ultimately, demands that accurate creditworthiness and debt collection procedures be used. Suppliers are not seen as preferential creditors, so should a debtor fail to honour their debt, or worse, fail altogether, the risk suppliers are exposed to is inevitably high.

Current methods of evaluating a potential debtor's creditworthiness are predominantly ad hoc and bespoke; ultimately, suppliers' management has to decide if the risk associated with a given contractor's trade is worthwhile. If an accurate method of evaluating creditworthiness was available, it could provide two positive macro outcomes. First, contractors identified as being too risky (to be allowed credit), would be restricted from working on projects beyond their own financial resources. The result of this would be that only those contractors with adequate resources could tender for and carry out construction projects within their own financially 'restrained' sphere and hence, this should help offset failure due specifically, to poor cash-flow management. Maybe, it is the case that suppliers hold the key to removing the financially unstable contractors in the industry? The converse side of this argument may be that at present, suppliers are overestimating (imposed) contractors' credit risk, so the industry is being starved of a potential source of capital. In such circumstances, maybe a 'barrier' is being erected to prevent the smaller (turnover) contractors from tendering for larger (value) projects?

The analysis and findings provided so far in this chapter have reinforced that suppliers are not simply organisations from which to purchase materials. They perform a task supplementary to this role (e.g. providing the industry with an additional form of working capital). By doing so, they have a significant influence on the construction industry, its targeted profit margins and the number of organisations operating within it.

Regardless of which viewpoint is taken concerning the previous assertions, the need for this research into contractor creditworthiness is underlined. The beneficiaries of such research will not only be suppliers, but the entire construction industry.

Having justified the rationale and need for this research, the next section of this chapter develops a conceptual contractor creditworthiness evaluation model. The model is derived from the knowledge and caveats identified from the literature review and, from the questions raised (and answered in part) by the analysis presented so far in this chapter.

3.5 CONCEPTUAL MODEL DEVELOPMENT

At this stage in the research, a conceptual model for defining the risk that suppliers expose themselves to when they furnish contractors with credit was constructed. The model had to be conceptual because the literature review identified a void in research pertaining to furnished credit risk. That is, there has been little empirical work in this field to date, upon which to mould such a model.

From the literature review it was evident that significant research resources have been consumed on the evaluation of contractors (e.g. Jaselskis and Russell, 1992; Russell, et al., 1992; Russell, 1992 and 1996; Severson, et al., 1993 and 1994; Holt, et al., 1994; Holt, 1996 and 1997; Hatush and Skitmore, 1997a; Chinyio, et al., 1998; Jennings and Holt, 1998). Essentially, the reviewed research regarding contractors could be categorised under two generic groupings:

i. prediction of contractor insolvency; and
ii. prequalification, for contractor selection purposes.

Though these two lines of research are useful for their specified predesignated tasks, the risk that contractors impose onto their suppliers remains largely ignored. Due to this void, the model presented in this chapter is entirely conceptual and provides a foundation around which future research and subsequent thesis chapters are structured. As the research within this thesis progresses and evolves, observations and variables are highlighted as being important factors when evaluating the risk associated with granting credit. Hence, the model presented in this chapter tends to undergo redefinition as the research (thesis) progresses.

3.5.1 Methodology of conceptual model

The methodology used throughout for the conceptual model development involved:

i. making observations of existing practices of credit control and debt collection from industry and identifying current best practice; and

ii. analysing previous research in a spectrum of research fields and considering its potential application to the task in hand.

Though these two points encapsulate a considerable quantity of information, this methodology had to be adopted because present practice and previous research can act both as a catalyst and a starting point for this research project.

A definition of 'creditworthiness' follows. This definition is included because it defines the 'dependent variable' for this thesis and provides a basis upon which future thesis chapters refer to. Essentially, the definition sets a footing upon which comparisons with present research and practices can be considered and gauged.

3.5.2 Definition of 'creditworthy'

The Oxford dictionary (1995) defines 'creditworthy' as:

> *'accepted as safe to lend money to, because of being reliable in paying money back'*

Initially, this seems an acceptable definition, until consideration is given to the amount of money included in the credit transaction and those finances available by the lender to lend. Because materials suppliers and contractors vary in organisation size, financial backing, management structure and so on (Lowe, 1987a; Muya, et al., 1997) consideration has to be given as to whether the parties' demands from a potential business interaction are compatible. That is, does the contractor being furnished credit impose excessive levels of risk onto the supplier, and is this level of risk within the supplier's tolerable risk threshold? What these observations imply is that there is a need to consider both the lending institute's characteristics and the potential debtor's attributes in tandem, during such evaluation exercise. Considering only one of the organisation's demands would be failing to consider the whole of the 'equation'. If these statements are accepted, it is evident that *both* supplier and contractor characteristics should be considered (i.e. in tandem) when defining an interaction between organisations as 'creditworthy'. For the purposes of this thesis the definition of creditworthy is:

> *'a classification assigned to an organisation, that has the ability and the intention to repay a debt, within a predetermined time-span, whilst not*

exposing the lender to levels of risk outside of their tolerable risk threshold due to the quantity of credit furnished'.

3.5.3 Technological influence

It may be argued that the advent of computer technology has the potential to remove the need for any goods from being purchased on credit. This is due to the supplier being able to, in theory, debit a contractor's account of the required funds at the exact time materials are purchased or delivered. However, to defend the need and value of this research, prominent observations from the literature review have been made in this respect, these being:

i. contractor cash flow is difficult to estimate (Tucker and Rahilly, 1988; Abdullah and Taylor, 1989; Kenley and Wilson, 1989; Kaka and Price, 1991 and 1993; Skitmore, 1992; Kaka, 1994; Navon, 1995). Hence, at the date materials are purchased there may be insufficient funds in the contractor's account to pay the bill. Subsequently, contractors are unlikely to want 'untimely' withdraws from their Bank account as this may:

    a.) induce overdraft facilities and / or extend overdraft usage: both resulting in additional Bank charges than compared to 'normal'; and

    b.) from (a) may give suppliers an indication of the contractor's financial standing if payment is refused.

From these observations, suppliers may revoke credit facilities to the contractor, which is depriving them of a form of working capital; and

ii. there is a need to have a high level of trust between supplier and contractor. At present the construction industry is renowned for its lack of trust and 'quality' relationships (Goddard and Jay, 1980; Peters, 1988; Sandras, 1989; Hillebrandt and Cannon, 1994; Shirazi, et al., 1996). To allow a supplier to have direct debit facilities to a contractor's account is presently unheard of; and

iii. the construction industry is renowned for not taking advantage of the latest 'up-to-date' technology and being very slow to change its working practices; and

iv. cultural change; from the above points it is evident that there is a need for a cultural change in the industry if computer technology is to become widely used for 'instant' payment of materials. Since industry change has been called for, a number of years ago (Emmerson, 1962), and still continues to be (Latham, 1994; Brandon, 1999), it is questionable if the pace of change is ever going to be anything other than 'slow'!

However, having highlighted the negative aspects of computer usage for debt collection, it is recognised that computer technology will, undoubtedly, in the future become more widely used in credit control and debt collection procedures, than it is at present.

Having briefly considered the influences of technology on suppliers' credit control and debt collection procedures, the question of *why* suppliers offer credit needs answering. There are many reasons why suppliers offer credit to contractors (Smith, 1987). Some of these reasons being:

i. cash on delivery, or cash before delivery imposes greater cost than furnishing a credit account (Smith, 1987);

ii. fellow competitors (suppliers) offer credit facilities, therefore, to remain competitive similar facilities have to be offered by all;

iii. interaction allows a greater 'depth' of relationship to be built between lender and borrower. Lowe (1987b) identified that even when a supplier was operating a monopoly they realised the benefits of long-duration interactions with customers; and

iv. from (iii), additional leverage may be exerted by both parties to achieve their mutual ends.

From the above observations it is evident that credit sales of construction materials will continue for a number of years to come and that there is a need for suppliers to be able to evaluate the risk that they expose themselves to when they furnish said credit. The conceptual model for defining contractor creditworthiness is now presented.

3.6 THE CONCEPTUAL MODEL

The conceptual risk assessment model described, takes into account: the dynamic construction business environment; the implications of managers' perceptions and decision making traits upon which decisions are made; the amount of credit allowed by the supplier; and the 'type' of business relationship between creditor and debtor. The model provides a framework around which the remainder of this research into evaluation of contractors' creditworthiness was developed.

The conceptual model considers the holistic nature of risk that crediting organisations expose themselves to when furnishing contractors with credit.

To accurately evaluate construction contractors' creditworthiness, the nature of the relationship between them and their suppliers should be considered along with the environment in which they operate (Altman and Sametz, 1977). The 'base model' presented (Formula 3.3) provides such a framework and is formalised via:

$$Cr = f\,(M, E, D, C, e) \qquad \text{(Formula 3.3)}$$

Where: ***Cr*** = Degree of creditworthiness (i.e. quantified credit risk);

M = Managerial, decision-making influences (business morals) within the contractor organisation;

E = External macroeconomic climate and associated bankruptcy levels;

D = Debt collection procedure efficiency and amount of credit allowed by supplier;

C = Contractor's financial characteristics (e.g. capital structure, working capital, current ratio, etc.); and

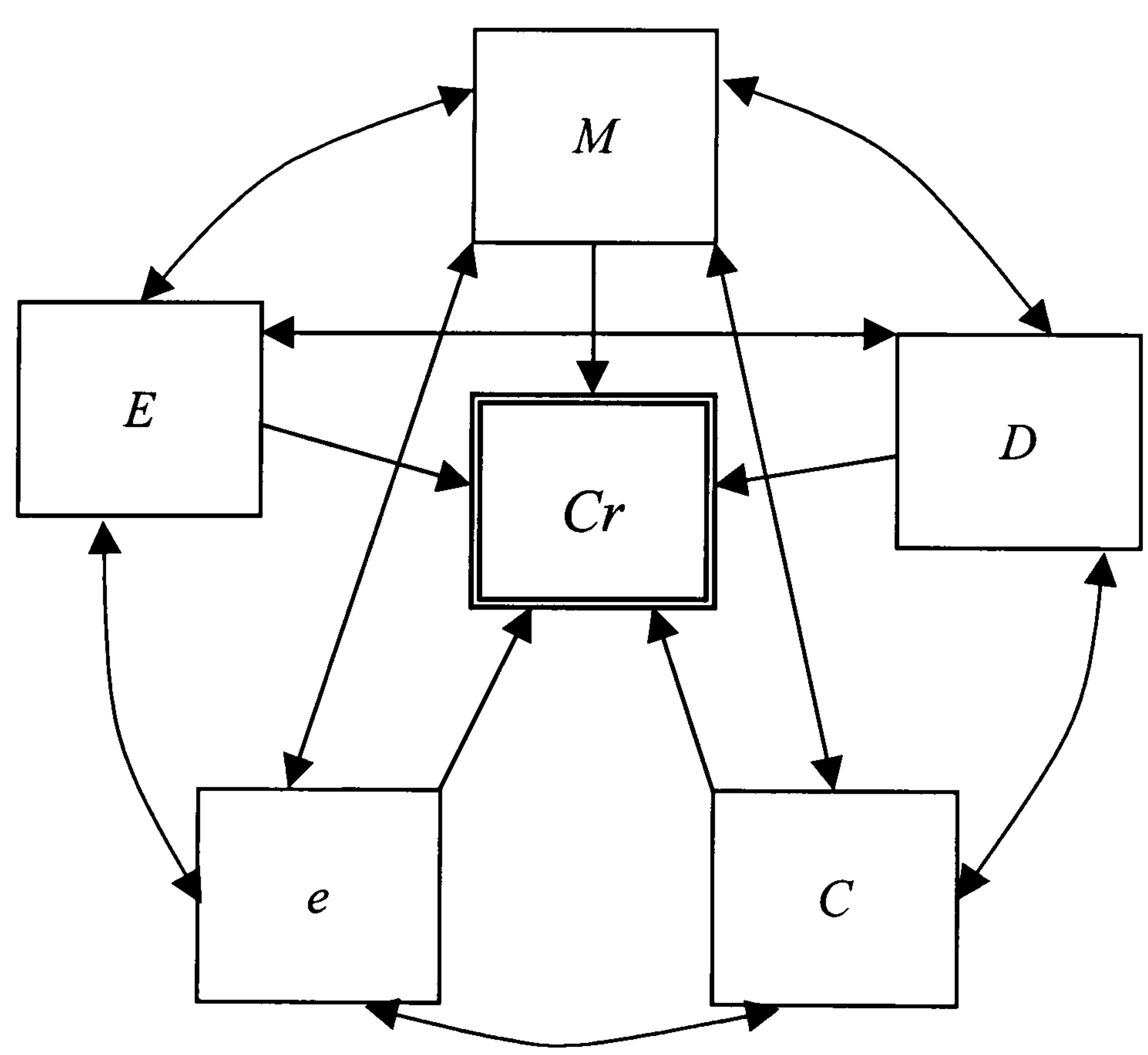
e = Error correction.

These variables are individually considered in greater detail in the following chapter, to highlight and explain their impact and interaction in this context.

The variables in Formula 3.3 were determined based on generic headings that the reviewed literature (Chapter 2) had been classified **and** from communications with practitioners (suppliers) regarding how to model contractors' credit risk more accurately than present procedures did. Because evaluation of a contractor's creditworthiness is restricted in resource allocation (Chapter 7), only 'direct' major influences on creditworthiness evaluation were considered, although Formula 3.3's generic variables do consider a significant number of contractor and supplier characteristics influencing supplier's credit risk. Further, since the model is conceptual and novel it does allow a basis for future research to build upon.

Figure 3.2 diagrammatically represents the various levels of the conceptual model (Formula 3.3) and identifies the interaction of the variables.

Figure 3.2
Interaction of conceptual creditworthiness model variables



Since all aspects of the model (referring to Formula 3.3) are presently viewed of equal importance, it follows that if one, or more, of the variables are ignored, then a less than optimum evaluation of creditworthiness will ensue. The model is aimed at using systems theory of 'gestalt'; that is, the summation of the individual parts is greater than their individual values in isolation (Kast and Rosenzweig, 1985).

The model addresses the present situation of ignoring major impacts influencing suppliers' credit risk analysis. A hypothetical example follows which identifies that accurate evaluation of credit risk demands a 'complete' analysis be undertaken. Two contractors are analysed, along with their respective materials suppliers; their characteristics are summarised in Table 3.1. These two scenarios reflect the extremes of credit risk. Though the example provided only highlights a small number of influencing factors regarding associated credit risk, and is somewhat contrived, it can be seen that risk for Example A is significantly less than that of Example B. At present, the proportional difference between respective credit risks is un-quantified; thus reinforcing the need for further research in this area.

3.7 SUMMARY

This chapter has identified the importance of materials suppliers to the construction industry. Through the evidence detailed, it is shown that suppliers are not only organisations from which to purchase materials; they also provide contractors with a form of working capital. By way of providing this working capital (furnished credit), suppliers expose themselves to considerable risk. When considering the observations made in the literature review, it is evident that methods used for credit risk evaluation of the supplier / contractor relationship could be improved upon. That is, present methods of risk evaluation tend to be reactive, ad hoc, non-scientific, inflexible, static and ignorant of many factors. To rectify this, a conceptual model has been presented which considers a multitude of factors that influence suppliers' credit risk. As findings and observations in this thesis evolve, prominent factors will be highlighted and fully investigated.

Table 3.1
Characteristics of two potential debting contractors, prevailing environment and materials suppliers debt collection procedures.

Conceptual Model Element	*Example A*	*Example B*
Cr	• Supplier is multi-national based, has turnover of £10bn and has one million credit customers.	• Supplier is a single outlet organisation, turnover of £1m and has 500 credit customers.
M	• Long term relationship with materials supplier • Dynamic organisational structure – constantly re-evaluating the market place for future work • Good working relationship with materials supplier	• Infrequent business relationship with materials supplier • Static organisational structure – relies heavily upon past clients for majority of future work • Business relationship based solely on price of materials being supplied
D	• Amount of credit required £10,000 • Materials supplier has good history of collecting debts on time.	• Amount of credit required £10,000 • Poor history of collecting overdue debts by materials supplier
E	• Boom period • Few company insolvencies	• Recession period • Lots of company insolvencies
C	• £100 m working capital • Assets £50m • Market value £1bn • Previous years pre tax profits £10m	• £10k working capital • Assets £5k • Market value £1000 • Previous years pre tax profits £500

The model presented forms a totally new approach to contractor creditworthiness evaluation. Since little work has been previously conducted in the subject domain, the concepts proffered are based on little empirical research. Hence, one might criticise the model in this respect. In defence of such accusations, it has been shown that present methods rely heavily upon analysis of previous years' accounts. Therefore, they fail to take account of important factors such as contractor management morals and market forces. The model should be viewed as a foundation upon which the remainder of this research is based. Ultimately, the only way a new model such as that proposed can gain industrial credence is through practitioners using it. Popper (1959) philosophised that 'new' techniques should undergo:

> *'verification through falsification'*

This statement summarises this chapter well. That is, because any model is only as good as the amount of error within it, knowledge of the error rate and causes of this error are equally as important as the model's ability to correctly classify the dependent variable.

The following chapters consider the generic variables of Formula 3.3 in greater depth. The chapters further dissect present research and current credit control practice to reveal prominent factors that can be used to assist evaluate supplier / contractor financial credit risk.

CHAPTER 4

THE CREDIT RISK MODEL: GENERIC VARIABLE DEFINITIONS AND DETAILED INVESTIGATION OF VARIABLES *M* AND *E*

4.1 INTRODUCTION

The previous chapter presented a conceptual model for analysing the risk that suppliers expose themselves to, when furnishing contractors with financial credit (Formula 3.3). The generic factors of this conceptual model are now considered in greater depth along with discussion of how these characteristics have an influence on suppliers' exposure to potential bad debt. In essence, the contents of this chapter outline the way that research into credit risk could be taken forward.

4.1.1 Chapter structure

This chapter consists of five main sections. These being:

- Section 1 introduces the chapter and its contents.
- Section 2 provides definitions of all of the elements included in the creditworthiness evaluation model.

- Sections 3 and 4 provide detailed investigation into elements *M* and *E* respectively.
- Section 5 details conclusions drawn from observations made in the chapter to this point and reviews the strategic future direction of research for this PhD thesis.

Following the introduction to the chapter (in the first section), the second section provides a description of all elements included in the creditworthiness model and future avenues of research that could be conducted into each of these elements. Following this, elements *M* and *E* are investigated in great detail and models for these respective elements derived. Section 5 reviews the findings in the chapter and provides a strategic overview for future research contained in this thesis (see chapter 1 section 1.3: Research methodology).

The reason why elements *M* and *E* were assigned specific research resources were:

i. the literature review had highlighted a significant amount of previous research into managerial and organisational decision making that could be adapted and used to model supplier credit risk;
ii. the literature review had highlighted the significant influence that the business environment had on organisations operating in it;
iii. that from i. and ii. elements *M* and *E* played an important role in measuring the risk that a contractor (furnished with credit) imposes onto the credit furnishing supplier;

iv. that the decision (by a supplier) to grant credit was ultimately a decision making continuum of interacting factors that needed investigation.

Based on these points, as well as the fact that modelling suppliers' credit risk had received minimal prior research consideration, elements *M* and *E* were hypothesised as being significantly important to warrant research attention in this particular thesis.

4.2 MODEL VARIABLE DETAILS

The following sections of the chapter provide details of the variables included in the conceptual creditworthiness evaluation model presented in the previous chapter.

4.2.1 *Cr:* Degree of creditworthiness

This is the dependent variable. It is intended that this variable is ultimately represented by a numeric on a calibrated, interval scale indicating the risk that the supplier is exposing themselves to when furnishing a specific contractor with credit. In essence, it represents the degree of creditworthiness for a given contractor and is related to the individual supplier's credit risk threshold. This figure is then reconciled against the financial asset structure of the supplier and the probability of the contractor in question defaulting on repayment. In turn, the obtained figure for *Cr* can be used to identify if the financial credit risk to the supplier results in a 'worthwhile' gain in utility (Chapter 5). *Cr* is highly dynamic and fluctuates depending on a number of factors.

Initially, materials suppliers must make a subjective decision regarding allowable credit risk (in this context). That is: how can different 'sized' (national *or* regional;

large *or* small turnover) suppliers reconcile whether the credit risk derived for a particular contractor is financially worth the potential profit from their trade? For instance, having established a degree of creditworthiness for a contractor (and the maximum credit limit that should be allowed in such instance), it follows that a multi-million pound turnover supplier may perceive the final qualitative judgement as a worthwhile risk. However, a supplier with a significantly smaller turnover may decide the opposite. Research is required with respect to how many contractors a supplier should furnish credit facilities to, whilst retaining *total* credit risk within allowable tolerances. Factors identified from the literature review that may impact upon this decision could be:

i. Competition by other suppliers: unless a monopoly exists, it follows that goods and services must be offered competitively. Risk associated with granting each contractor credit must be identified, priced and either incorporated within the cost of the service, insured against, or rejected. A balance must be achieved between the cost of risk and the opportunity for allowing competing materials suppliers the trade of a contractor. Consequently, a supplier's allowable risk is not only determined by the contractor but also by competing suppliers; so there is an 'external' macroeconomic force imposing upon this variable.

ii. Should discounts be offered to potential debtors if they honour their debts on, or before the dates stated in the supplier's terms and conditions of trading? Factors to consider here will be interest rates and credit duration.

iii. The construction industry is cyclical by nature; so how often should re-evaluation of creditworthiness occur? For instance, if a contractor's workload, and hence cash-flow, is dependant upon a single contract, it follows that at contract completion the creditworthiness of the contractor should be re-evaluated. Though this is a contrived example it underlines the need for suppliers to constantly monitor the workload of their customers. Subsequently, resources consumed on creditworthiness evaluation need 'balancing' between improving supplier turnover and the cost of such creditworthiness evaluation.

4.2.2 *C:* Contractor's finacial characteristics

Previous research has highlighted that internal (organisational) financial characteristics can identify a contractor's possibility of survival into the next trading period. Langford, et al. (1993) evaluated the accuracy of ratio analysis and Altman's Z-score in predicting company insolvency. It was deduced that due to a lack of information regarding construction industry financial 'norms', ratio analysis and Z-scores were unable to be compared other than relatively (i.e. intra-industry sector).

When considering contractor ability to repay debts there is a need to investigate their capability to perform. If performance is 'poor' the probability that sufficient income will be generated to meet credit repayments is questionable (and vice-versa for 'good' performance). Performance in this context relates to contractors' experience, ability to carry out the project to specification and within restraints imposed upon them.

The internal characteristics of a potential debtor have to be taken into account also. A tenable link must exist between the finances of a debtor's organisation, and characteristics that influence their workload and associated credit risk level. The basis for this argument is as follows. An organisation can have all the goodwill needed to honour debts, but if they fail to have the finances, then goodwill is worthless. Thus, a form of 'physical' financial measurement is required. This will predict the future status of the debting organisation by taking into account workload (cash incoming) and current liabilities. 'Cash' in this context refers specifically to current assets (or part thereof).

4.2.3 *E:* External macroeconomic climate and associated bankruptcy levels

The construction industry has been referred to as:

> *'the barometer of the economy'* (Nash, 1996)

Risk to creditors inevitably varies according to the economic climate and credit limits must be dynamic to reflect this. Arguments for including this variable in the model are that in 'boom' times, the probability of a contractor becoming insolvent is somewhat reduced than when compared to 'recession'. Furthermore, Lowe (1997a p.84) identified:

> *'the peak failure rate for the self-employed and companies in the construction sector appears to be twice as bad as for other industries'*

Obviously, because of these observations, organisations offering credit to construction related organisations are exposing themselves to greater risk than their counterparts in other sectors of industry.

4.2.4 *M:* Managerial, decision-making and organizational influences

Failure to consider *how* a potential debtor views and reacts to credit conditions will result in a key area of analysis being ignored. This is an important aspect because inevitably, someone from the debting organisation has to sign cheques. If the firm's perception of payments varies to that agreed in the supplier's contract of sale, then risk and disagreements will ensue. Three key factors impacting upon organisations' decision-making processes have been identified. These being:

- Contractor-supplier relationships i.e. duration of the relationship; specification and delivery requirements of materials; and the strategy and leverage imposed by supplier and contractor when interacting.
- Organisational decision-making process i.e. who makes the decision to pay creditors? Structural characteristics of the debting organisation; the quantity of resources available to evaluate potential debtors; and the influences of market turbulence.
- The individual and the environment: Is the contractor a prospector, analyser, defender or reactor? (a definition of these typographies is given later in this chapter) as defined by Miles and Snow (1978). Consideration also needs to be given to the resources available to the supplier to evaluate a contractor i.e. informational quantity and quality as well as both time and finances available to make such decisions.

4.2.5 *D:* Efficiency of debt collection procedure and amount of credit allowed

Having evaluated 'creditworthiness', the need to quantify the amount of credit that should be allowed logically then follows. This research argues that the greater amount of credit allowed a contractor, is positively proportional to the amount of risk. Beyond the scope of this thesis, but requiring research, is the need to identify and develop the function of the finance-risk curve of materials suppliers i.e. when considering credit limits and maximum number of debting contractors is it linearly, quadratically, logarithmically or other mathematical functionally proportional?

It is accepted that money has a time value (Pilcher, 1992; Sizer, 1989) so an efficient debt collection procedure alone, reduces credit risk. Thus, a factor relating to supplier debt collection efficiency must be included.

4.2.6 *e*: Error correction for the model

Since the 'problem' revolves around human interaction, a totally quantitative model is impossible. People react differently to different business / corporate situations. Furthermore, since certain variables include subjective factors that can only be measured by means of (e.g.) utility functions (such as aspects of managerial perceptions) then this is another area for 'errors' to exist (Oltman and Lackritz, 1991 p.784).

Ultimately, quantitative analysis of debtor risk can be derived from:

$$Cr = f\sum_{i=1}^{n}(VX_i) \qquad \text{(Formula 4.1)}$$

Where '*Cr*' = as detailed in Formula 3.3; VX_i are the $_n$ variables considered (attributable to) the conceptual model's five (X) components; and VX_i is a function of:

$$VX_i = f(UVM_i, UVE_i, UVD_i, UVC_i, UVe_i) \qquad \text{(Formula 4.2)}$$

Where: UVx_i consist numerous sub-variables considered by the (potential credit furnishing) supplier such that:

$$UVx_i = f(v_{xi}) \qquad \text{(Formula 4.3)}$$

Where: v_{xi} ε of Vx_i. That is, (Vx_i) have sub-utility functions characterised by v_{xi}. The sub-utility functions are quantified by transposing 'natural' non-tangible aspects onto a scale ranging from zero to one representing their utility value i.e. 1.0 = maximum utility (Holt, et al., 1994).

Having now presented a description of the conceptual contractor creditworthiness evaluation model variables and their influence on Formula 3.3, the research in this chapter now justifies *why* generic item '*M*' and '*E*' have received greater research attention than compared to their counterparts.

The reasons for concentrating on these variables were that the literature review identified that:

i. the decision to make a payment for goods (which have been purchased on credit) is ultimately a decision-making continuum; and

ii. that the economic business environment has a large influence on the amount of credit risk a supplier is exposed to.

Because of these observations and the lack of research that was specific to analysing credit risk in this context, investigation into items '*M*' and '*E*' was warranted.

Research associated with '*D*' (suppliers' debt collection efficiency and amount of credit allowed a debtor) is detailed later when:

i. results of a UK national survey of suppliers' credit control and debt collection procedures are investigated (Chapter 7); and
ii. when multi-variative discriminant analysis is conducted on the survey responses to observe factors influencing suppliers' utility achieved from granting credit (Chapter 8).

When considering item '*C*' (contractors internal characteristics) the literature review identified that a considerable amount of work had been conducted in this domain. For instance, ratio analysis was investigated by Fadel and Parkinson (1978); Kangari, et al. (1992), Russell, (1992); Langford, et al. (1993); Abidali (1995); and Russell and Zhai, (1996) amongst others. Because previous research had dealt with financial analysis of contractors' accounts, then potential future research would be revisiting a domain that had received considerable prior attention.

The culmination of the observations relating to the variables in the conceptual model meant that items M and E required research attention more so than compared to the 'other' variables; these variables are now considered.

4.3 ELEMENT M: MANAGERIAL DECISION-MAKING AND ORGANISATIONAL INFLUENCES

The sub-model now presented specifically concentrates upon generic item M of Formula 3.3. The sub-model contains variables that should be considered by suppliers; when quantifying 'managerial' risk associated with furnishing construction contractors with financial credit. This sub-model graphically derives the unique 'supplier credit risk profile' of any specific supplier / contractor interaction. 'Contractor' in this sense is defined as any organisation seeking financial credit facilities from a supplier. The sub-model also takes into account a number of human and organisational traits and characteristics, not specifically relating to potential debtors' financial accounts. This is something that no other creditworthiness evaluation model has ever specifically, or implicitly contemplated. Indeed, the sub-model presented in this chapter builds on the many of the caveats identified in the literature review (Chapter 2), that are associated with present techniques for contractor creditworthiness evaluation. By considering factors relating to potential debtors' personal managerial and organisational structure characteristics, the accuracy by which contractors' creditworthiness may be measured, is greatly enhanced. That is, suppliers should be able to determine whether the risk a contractor poses as a debtor, is within their 'credit risk threshold'.

By understanding and correctly applying the sub-model contained within this chapter, materials suppliers will reduce their probability of incurring bad debt. It will be observed that suppliers' and contractors' characteristics are jointly considered. This is due to the definition of creditworthiness that is being used for this research (see chapter 3). This definition identifies that the decision (by a supplier) to grant a contractor credit is a unique and dynamic process, requiring consideration of creditor (supplier) and potential debtor (contractor) characteristics (i.e. to determine if the degree of risk threatened is acceptable, or not).

Construction differs from other industries in that each project is unique and involves an amalgam of numerous professionals and organisations (Murdoch and Hughes, 1996). Inevitably, the 'bringing together' of these project participants results in new business relationships being established and older ones being developed (Peters, 1988; Peters and Waterman, 1989; Harré and Gillett, 1994; Hillebrandt and Cannon, 1994; Jarillo, 1995). This section of the chapter concentrates on construction contractors' relationships with their materials suppliers, and the psychological and managerial decisions taken by contractors, regarding payment for goods on credit. The sub-model is designed to graphically illustrate risk levels for crediting organisations (suppliers) with respect to their interaction with a potential debtor (contractor). It is important to note that this sub-model is entirely 'novel'.

Variables included in the sub-model are not presently calibrated. That is, they are represented by a subjective continuum. However, the sub-model represents an entirely new direction for investigating one aspect of supplier / contractor interactions, with particular respect to *contractor creditworthiness evaluation*. The sub-model should therefore, be viewed as a foundation upon which future research could build. For example: to confirm the best evaluation variables (discriminators) in this specific context; to calibrate the measurement of these variables; and to develop respective 'importance coefficients'. These latter issues are each voluminous in themselves and as such, beyond the scope of the present study.

This section of the chapter discusses generic item *'M'* (Formula 3.3) in its three, principal constituent parts. These are: Part *M*A: contractor / supplier relationships; Part *M*B: organisational decision-making; and Part *M*C: the individual and their environment.

All variables included in the sub-model were selected from previous research relating to:

- organisations' business interaction with other organisations;
- organisations interacting with their business environment; and
- organisational structures.

Sub-model *M* variables, embrace all aspects of managerial characteristics that have the potential to impact upon the supplier / contractor business relationship, with particular respect to repayment of debt. Henceforth, each variable within generic item *M* is given its own unique identity. For example, V_{MA1} is variable 1 of component A of generic item *M*, V_{MA2} is variable 2 of component A of generic item *M*, V_{MB3} is variable 3 of component B of generic item *M* and so on. These identities are used throughout the remainder of this thesis and cross-referenced with the

Figures detailed later (for example, Figures 4.2, 4.3 and 4.4). The variables for evaluating a contractor's creditworthiness are now detailed. This is followed by a description of how to 'measure' a supplier's risk associated with allowing a contractor credit facilities.

4.3.1 Model part *MA*: Contractor / supplier relationships

Increased demand for quality necessitates that contractors work closer with their materials suppliers, than used to be the case (Berggren, 1993). The construction industry has become notorious for its inability to supply clients with projects on time, to budget and desired quality (Simon, 1944; Emmerson, 1962; Banwell, 1964; Latham, 1994; Holt, 1995). Hence, suppliers who may adversely impact client satisfaction should be avoided wherever possible (Proverbs and Holt, 1999). Conversely, there is a need for suppliers to recognise their financial risk, when furnishing contractors with credit. In short, contractors and suppliers should carefully consider their mutual business relationships (ibid.). The variables presented in this chapter have the ability to 'model' the supplier / contractor interaction with particular respect to the risk involved with granting a contractor financial credit.

4.3.1.1 V_{MA1}: Type of relationship

Sako (1992) modelled customer / supplier relationships at two extremes to reflect the degree of 'trust' between these two trading organisations. 'Trust' was defined as being '*goodwill*', '*competence*' or '*contractual*'. '*Goodwill*' trust results from organisational mutual respect. '*Competence*' trust is the recognised ability of organisations to carry out a contract between them. '*Contractual*' trust is breached if either organisation fails to achieve the specific performance requirements of a contract. The closer organisations become to '*goodwill*' trust, the greater their probability of a successful business partnership, in terms of achieving the mutually agreed 'project target(s)'.

Business relationship development is also influenced by environmental and organisational factors. In particular: time duration of the supplier / contractor relationship; specification of materials (output) being produced; and culture and strategy of the interacting organisations. These variables are now discussed.

4.3.1.2 V_{MA2}: Duration of relationship

Longer (time duration) business relationships engender mutual reliance. Deming (1986) and Sako (1992) analysed the time duration for strategic partnerships to become evident and found that this evolved over years, rather than weeks or months. Opportunities to build long-term (supplier / contractor) relationships in this same way are potentially reduced; due to individuality of non-mass produced materials used in construction. However, many projects require recurrent materials, all of which can be single sourced. Hence, there *is* opportunity within construction for suppliers and contractors to build strategic working relationships. These have previously been defined as 'Strategic Downstream Alliances' (Proverbs and Holt, 1999).

4.3.1.3 V_{MA3}: Specification criteria

'Bespoke' materials induce greater interaction between buyer / seller due to the customer requiring the supplier to fully understand their individual, bespoke needs. Communication amongst organisations requiring 'standard' items (such as concrete blocks) concentrates predominantly on price and availability, rather than specification. Thus, relationships are in one way a function of the uniqueness of the item being purchased. Interaction amongst organisations inevitably helps creditors (suppliers) understand their customers' potential future work-load and management philosophy; this providing an insight to potential repayment.

4.3.1.4 V_{MA4}: Delivery criteria

Similarly to V_{MA3}, delivery can be classified between the extremes of 'bespoke' and 'standard'. The more bespoke delivery criteria are, then the greater the amount of communication tends to be between buyer and seller. This induces greater mutual understanding of each organisations' needs and abilities. For example, it allows a supplier to gain knowledge regarding whether the contractor has had sufficient foresight to order materials well in advance of needing them on site, or otherwise. From observations such as this, a supplier can build a 'psychological picture' of the contractor with respect to their ability to pre-plan. Because there is a cost implication with having to use a bespoke delivery method (compared to 'normal' delivery systems), contractors who continually require bespoke delivery systems are, generally incurring extra cost. Hence, by observing contractors' delivery criteria, suppliers can determine whether the contractor is proactive or reactive in terms of logistics preplanning.

Reactive practices (e.g. deliveries) indicate an inability to forward plan, they mirror an organisation going from crisis to crisis. Because crisis management sometimes fails to produce the required result(s), contractors continuing to operate in this way are a greater credit risk than a contractor who exhibits good preplanning abilities.

4.3.1.5 V_{MA5}: Culture

Handy (1993 pp.180-216) identified four cultural organisational types: Power, Role, Task and Person. A brief description of each cultural type follows:

- *Power Culture*: predominantly entrepreneurial organisations who have an all-powerful leader from where the organisation's power radiates. The people working in a power cultured organisation display a large amount of trust between themselves. Communication between the organisation's participants is on a personal basis and takes place only if and when required. There are few rules and little bureaucracy. Few key individuals in the organisation control all of its activities. Decisions are taken to maintain a balance with the environment in which the organisation operates. The organisation is proud of what it is and its future targets. People who work in a power culture are politically minded, risk takers. Power cultures are predominantly small in size and can fail if too many high powered leaders become employed. The atmosphere created by 'culture' employees is one of competition, which subsequently leads to large turnover of middle 'layered' management. The culture exhibits characteristics of arrogance and abrasivness. Possible flaws with power cultures are that they can become stagnant and as bad as they can be effective.

- *Role Culture*: highly bureaucratic, working in a logical and structured manner. The organisation has departments that concentrate on specific chores. People operating in a role culture are required to carry out specific tasks asked of them. The 'position' of a person in the organisation's hierarchy denotes the power that person has. Rules and standard procedures for carrying out tasks influence the organisation. A stable environment allows role-cultured organisations to flourish. Role cultures are slow to adjust to changes in their business environment and to the advent of competition in their market place. Role cultures exhibit characteristics that take advantage of economies of scale, technical expertise and product knowledge. However, role cultures tend to not exhibit organisation flexibility, product innovation, or skills in adjusting production cost so that the product remains competitively priced.

- *Task Culture*: job or project orientated, task cultures aim to bring together the correct people to accomplish the task (objectives) presented to them. The level of a person's influence within a task culture is based predominantly on their knowledge. A further characteristic of a task culture is that it is very adaptable and unifies the people within it, so that their goals are set towards achieving the project target(s). Decision-making is speedy and made by individuals with the prerequisite knowledge. Task cultures are flexible and sensitive to market and environment conditions. However, the culture has difficulty in taking advantage of economies of scale, or having great *depth* of knowledge. The task culture thrives on speed of reaction, integration of the workforce, sensitivity, and creativity. Control of a task culture is difficult, because the organisation's 'top' management has to observe a number of 'groups' activities. When resources become constrained, 'group' leaders engender a competition ethos into their workers, so that their team can attract resources. When competition is induced, individuals reassess their psychological contract of employment: generally morale drops and the job becomes less satisfying. The task culture is preferred by middle and junior level employees and by most managers. It represents the 'fashionable' culture at present. However, Handy (1993 p.189) provides a warning:

> *'If organizations do not all embrace this culture it may be that they are not just out-of-date and old-fashioned - but right'*

- *Person Culture*: not found in many organisations. It assists participating individuals in achieving their desires. There is little, if any, organisational structure and little hierarchy. Power tends to be 'knowledge' power. Individuals who are involved in a person culture organisation are difficult to manage, as they want to achieve their own targets. Personal power can be used to 'manipulate' an individual. However, individuals in person cultures tend not to be impressed by personality.

Evidently, each of these cultures has their own individualistic traits and working practices. For two different organisations to work together efficiently, there is a need for both cultures (supplier and contractor) to be able to 'respect' each others' working methods and culture. If this respect cannot be achieved then conflict will ensue between the interacting organisations. Because conflict tends to induce arguments, there is a link between supplier credit risk and the supplier and contractor's cultural characteristics. That is, there is a need for mutual respect of each organisations' culture so that amicable, non-argumentative working practices can be observed.

4.3.1.6 V_{MA6}: Strategy and leverage

The longer a supplier works for a customer the greater the demands that customer will impose upon them. Shorter delivery times, modified specifications etc. may all be experienced. Jarillo (1995) distinguished different organisational working relationships (Figure 4.1). By confirming customer needs and interaction characteristics (negotiation, bidding, selection etc.), the relationship 'method' between supplier and contractor can be identified.

Figure 4.1
Interactions between ownership mode and approach to the relationship

Supplier : Contractor Ownership Mode	***Supplier : Contractor Interaction Approach***	
	Co-operative approach	*Non-co-operative approach*
Common Ownership	Vertically integrated company	Bureaucracy
No Common Ownership	Strategic Network	Market

From Jarillo (1995)

Figure 4.1 shows the potential interactions of two organisations. Jarillo (1995) suggested that at the extremes of an organisational relationship, one organisation may decide to purchase the 'other' organisation. When this occurs, the conglomeration of the joint organisation can exhibit characteristics of a bureaucracy or become vertically integrated. This last sentence is depicted on the top line of Figure 4.1. Conversely, organisations who are not under common ownership can decide to either interact with another organisation on a strategic or market type based basis. Here, 'market' basis is defined as the organisations being at arms-length (ibid.) and having little consideration for the organisation they are interacting with.

'Strategic network' is when the interacting organisations have a mutual respect for each other and desire the 'best' for both parties. When it comes to relating Jarillo's work to contractor creditworthiness evaluation, it is hypothesised that when suppliers and contractors have 'good' relationships, they rely on the strategy and leverage of the other organisation to achieve each organisation's desired outcome. In turn, if a relationship between a supplier and contractor is 'good', credit risk to suppliers is significantly reduced, when compared to 'other' less harmonious supplier / contractor relationships.

From the initial review of literature so far in this chapter, no definitive answer is evident regarding how best to develop a supplier / contractor business relationship; other than to base that relationship on trust and strive for mutual objectives and satisfaction of the same. Trust is dependent upon many factors. To idealise one particular method of supplier / contractor relationship development is impossible due to a plethora of impacts, so 'other' variables imposing upon relationships should also be considered. These are now discussed.

4.3.2 Model part *M*B: Organisational decision-making

Consideration of aspects related to organisational decision-making will help suppliers understand a relationship between themselves and a potential debtor (contractor) in a more detailed and accurate manner. Decision-making is influenced by a multitude of variables. Since human behavior is involved, the intrinsic nature of the environment, surrounding individuals, and organisational structure are all matters to be considered (op. cit.). Fredrickson (1986) contended that organisational (structural) characteristics influence strategic decision-making. In particular, formalisation, complexity and centralisation were identified as key impacts. Fredrickson used Mintzberg's research to highlight organisational structures that represent the characteristics influencing decision-making processes. These structures are: simple structure, machine bureaucracy, and professional bureaucracy:

- *Simple Structure*: Direct supervision is the prime co-ordinating mechanism, the key section of the organisation being the strategic apex (Board of Directors, President, Executive Committee etc.).

- *Machine Bureaucracy*: The prime co-ordinating mechanism is the standardisation of work processes, with the key section of the organisation being the technostructure (Strategic Planning, Controller, Operations Research etc).

- *Professional Bureaucracy*: Standardisation of skills is the prime co-ordinating mechanism, with the operating core (that section involving Machine operators, Salespersons, Purchasing Agents etc.) being the key part of the organisation.

From analysing organisational structures, Fredrickson (1986) hypothesised that decision-making variation would exist. From this hypothesis a number of variables regarding organisational structure and the decision-making process are identified following V_{MB1}.

4.3.2.1 V_{MB1}: Organisational influences

Complex decisions require considerable information processing, often by a number of people. In the context of this chapter (and thesis), it would not be unreasonable for a supplier's sales representative, credit control manager, branch manager and area manager to be consulted regarding whether to furnish a contractor with credit and / or to what extent (credit limit). Such group opinion aims to obtain an optimal decision. The purpose of 'group think' as termed by Janis (1982; 1985), is to obtain the thoughts of a number of individuals with a 'common' aim (consensus opinion). Hence, the group is normally constructed of those individuals who have common values and notions. However, the possibility remains that certain factors and elements of risk may be overlooked in such a group.

4.3.2.2 V_{MB2}: Problem and incrementally orientated decisions

Incrementally orientated problems are optimally solved when organisations are structured towards a formalised machine bureaucracy (ibid.). Variation from this spawns an amount of inaccuracy. In terms of contractor creditworthiness evaluation, the potential debtor's (contractor's) structure and operating environment should be considered, to ensure that a 'match' is present between the contractor organisation structure and its business environment. If it is not, less than optimal decisions will ensue. If debting organisations (contractors) make business decisions that result in outcomes which are less than 'acceptable' (compared to the optimal possible outcome), then the probability of them surviving (remaining in business) and being a good credit risk is severely reduced. Hence, there are obvious ramifications for creditors (suppliers) if the probability of a potential debtor becoming insolvent increases.

4.3.2.3 V_{MB3}: Dynamic and innovative decisions

It was further hypothesised by Fredrickson (1986) that centralist, simply structured organisations make better decisions than other types of structured organisations. Subsequently, as with variable V_{MB2}, this highlights the need for suppliers to identify a potential debtor's environment; and evaluate if their structure is appropriately configured to operate within it.

4.3.2.4 V_{MB4}: Political decisions

Professional bureaucracies are better at making political decisions than other types of organisational structure (ibid.). Subsequently, by considering V_{MB4}, it is possible to evaluate if the potential debting organisation is a high or low credit risk with respect to this particular characteristic.

4.3.2.5 V_{MB5}: Environmental influence

The business environment largely influences the effectiveness of managerial decisions (Hambrick and Mason, 1984). Where turbulence and emergencies are present in the business environment, it was concluded that heterogeneous teams made more effective decisions than homogeneous ones. Since the general business climate in which all organisations operate is prone to booms and slumps, there is always a degree of turbulence present. Therefore, heterogeneous structured construction contractors will be less of a credit risk for suppliers than those with homogeneous structures. Horvarth and McMillan (1979) identified that organisational characteristics impede the strategic decision-making process; positioned power within an organisation had great influences in this respect. Opposing Fredrickson's (1986) hypotheses, Horvath and McMillan (1979) discovered that autocratic organisations' decision-making was responsive with a more informal approach than occurred in simply structured organisations.

4.3.3 Model part *M*C: The individual and business environment interaction

To 'measure' the variables detailed in the following section of this paper, it is necessary for the evaluating party (supplier) to observe a contractor's working practices, work conditions, employee interaction etc. and make judgements regarding how this potential debtor reacts to situations that occur in the business environment. Part of a national UK survey of materials suppliers' credit control and debt collection procedures identified that nearly sixty per cent of suppliers used sales representatives' reports, as a decision-making implement to gauge whether a contractor was 'creditworthy', or not. Hence, when questioning if it is practical and economical for a supplier to make observations of a contractor, as detailed in this section (*M*C) of this chapter, it seems that suppliers already observe the working practices of contractors before offering them credit facilities.

However, suppliers reported that the accuracy of sales reports (regarding contractor creditworthiness) was limited. Because of this inaccuracy, the variables in section *M*C aim to suggest prominent characteristics of a contractor that could be observed by suppliers in this respect. From these observations, a general overview of a potential debtor's ability to remain solvent and their philosophy for payment of goods on credit can be better understood.

March and Simon (1958) discovered that decision-makers are bound by numerous restrictions. These are now detailed.

4.3.3.1 V_{MC1}: Quality and quantity of information available

Quantity of information influences decision-making. Traditional wisdom suggests that information is always restricted in quantity and quality. Furthermore, the 'cost' of gathering information is finite. Hence, (particularly in business) decisions normally have to be made with less than optimal amounts of information, so 'satisfactory' rather than 'optimal' decisions ensue. The greater amount and better quality of information available to a crediting organisation (supplier), then in theory, the less chance the supplier has of making a poor decision regarding the risk associated with granting a contractor credit. However, there is an obvious cut-off point beyond which information retrieval is uneconomical.

4.3.3.2 V_{MC2}: Cognitive capacity

Crediting organisations (suppliers) should 'analyse themselves' to identify whether they fully understand the financial risk implications of allowing (contractors) credit. Evidence of such poor understanding is a supplier incurring bad debt. If suppliers have proved themselves capable of accurately analysing contractor creditworthiness then this implies good cognitive capacity. Conversely, large amounts of bad debt may indicate the reverse.

4.3.3.3 V_{MC3}: Resource constraints

As with variable V_{MC1}, resources for contractor creditworthiness evaluation are finite. The amount of resources expended (generally) directly relates to the accuracy of decision made. The greater the resource consumption, the more reliable and accurate the decision; but this cannot be automatically assumed in all cases (Black and Bradley, 1996). Here, resources are defined as including time, money and people.

4.3.3.4 V_{MC4}: Goal definition

Following on from variables $V_{MC1\text{-}MC3}$, corporate goals are often broadly (vis-à-vis specifically) defined (ibid.). Consequently, the possibility of achieving definitive decision-making satisfaction is reduced. This is due to individuals participating in group decision-making, having different perceptions of what the 'real' objective(s) of the forum are. An example of conflicting intra-organisational goals may be a supplier aiming for maximum turnover, whilst the credit control department is targeted towards minimising bad debt. The corporate priorities of the organisation need therefore to be clearly communicated to all parties concerned. Definitive goal announcements at an early stage of any evaluation meeting will remove any ambiguities. In relation to generic item *'M'* of Formula 3.3, the goal should be primarily to accurately evaluate creditworthiness. This objective should be made clear to all parties involved in making a decision whether to grant a contractor credit and to what level such credit (limit) should be fixed at.

4.3.3.5 Environmental influences

Organisations and their business environment inevitably influence each other (Holt, et al., 1999). Research suggests that in a stable environment bureaucracy flourishes, whilst an alternating environment is more conducive to a flexible structure (Hedberg, et al., 1976). Subsequently, decision-making is also a function of environmental influences.

Miles and Snow (1978) proposed four fundamental types of decision-maker: prospector, analyser, defender, and reactor; each of these typologies having their individual characteristics.

- *Prospectors:* Opt for flexibility and show entrepreneurial and dynamic flair; they exploit new markets and product opportunities; are constantly looking for new avenues of trade; their structure is flexible and adapts to the environment; there are few formal rules and regulations. 'Balancing' is required to maintain the efficiency brought about by this 'chaos'. They tend to be effective but inefficient.

- *Analysers:* Look at all options and solutions; they aim to minimise risk and maximise profit; movement into new markets is carried out only after their viability has been proven; certain sections of the organisation are highly standardised with lots of rules and procedures, whilst others are highly adaptive and have few, if any, rules and procedures.

- *Defenders:* Are concerned with stability and efficiency; they aim to go into niche markets and concentrate upon a narrow range of services or products; emphasis is placed upon hierarchical control and centralised decision-making; they tend to concentrate upon planning for efficiency and cost control and are not looking to diversify.

- *Reactors:* Are a combination of all the former, so their strategic behaviour patterns are unpredictable. They attempt, unsuccessfully, to follow either of the other three typologies; poor performance is expected due to them being unable to respond to the environment correctly. This type of decision-maker moves from crisis to crisis.

Having described the salient characteristics of these 'typographies', a number of issues can be deduced to assist in measuring the risk involved with suppliers granting financial credit to construction contractors.

4.3.3.6 V_{MC5}: Flexibility, adaptivness and entrepreneurial vigour

Suppliers should evaluate potential debtors' markets to identify any match between a contractor's environment and strategic decision-making typography. For organisations performing in a market that demands flexibility, adaptivness and entrepreneurial vigour, a 'prospector' typography is optimal followed by 'analysers' and then ' defenders'. 'Reactors' in turn induce the greatest amount of credit risk onto a supplier when flexible and entrepreneurial skills are called for by the business environment.

4.3.3.7 V_{MC6}: Exploiter of new markets

'Prospectors' are the best decision-makers for any organisation exploiting new market places. This is followed by 'analysers', 'defenders' and 'reactors' in a similar, descending order of importance. Hence, when the business environment has potential new markets for contractors to exploit, a contractor with a 'prospector' type typography should be sought by suppliers, if the supplier wants to minimise their risk associated with granting the contractor credit. This is because the prospector typography induces less credit risk onto a supplier who has furnished the contractor with credit (than compared to the other typographies). This is because

4.3.3.8 V_{MC7}: Adaptive organisational structure

Having some relationship to V_{MC5} and V_{MC6}, if the potential debting organisation (contractor) is to operate in new market places, be flexible, adaptive and entrepreneurial, then 'prospectors' offer good adaptive decision-making organisational structures. Hence, 'prospectors' are a low credit risk for suppliers when adaptive organisational structures are desired. 'Reactors' are a poor credit risk in this context. In between these two extremes 'analysers' tend to induce less risk than 'defenders'. The reason for this reduced credit risk (with prospectors), in relation to exploiting new markets, is that this typography continually seeks to look for new market places where employment can be sought. Because employment (generally) means a contractor will remain solvent, credit risk to suppliers is somewhat reduced. However, there is a need for suppliers to consider the 'strain' on respective contractors' working capital and resources, so that contractors who are working beyond their own capabilities are identified.

4.3.3.9 V_{MC8}: Effectiveness

'Prospectors' have effective decision making traits. Subsequently, in terms of creditworthiness evaluation this suggests they will be less of a credit risk than other typographies. This is due to 'prospectors' wanting to complete outstanding work and move onto new projects as defined in variables V_{MC5}, V_{MC6} and V_{MC7}. The decending 'order' of credit risk for materials suppliers, for Miles and Snow's typographies follows that given for V_{MC5}, V_{MC6} and V_{MC7}.

4.3.3.10 V_{MC9}: Efficiency

Efficient working practices are most often demonstrated by 'defenders'; who tend to consider a multitude of solutions to the 'problem' in hand. Ultimately, 'defenders' choose the most cost sensitive option to achieve their desired outcome. 'Defenders' should by nature, be best at controlling their own cash flows and portray a better (lower) credit risk for suppliers. In line with Miles and Snow's definition, following on from 'defenders', the 'analyser' then 'prospector' and finally 'reactor' typographies show reducing abilities to be efficient in this context. Hence, by analysing potential debtor typography and observing the contractor's efficiency a measure of supplier potential credit risk can be ascertained.

4.3.3.11 V_{MC10}: Risk minimiser

The 'analyser' typography is best at minimising risk associated with long term survival; 'analysers' therefore reflect a lower risk for crediting organisations. However, because of the definition of creditworthiness that is being used for this thesis (see chapter 3) there is a need for both the supplier's and potential debtors' typography to be considered jointly. Since both suppliers and contractors operate in a business environment that is competitive, when a potential business opportunity presents itself there is a need to make a quick, yet accurate decision, of whether to participate in the interaction, or not. One factor that will need consideration is the risk taking abilities of fellow competitors in the same market place. This is because competition demands that risk (gambles) are undertaken to gain competitive advantage over 'other' organisations operating in the same market place. If analysers take too long in evaluating associated risk, then excessive cost and possible time delays ensue; all of which can be taken advantage of by competitors. Because suppliers have to expose themselves to risk to offer contractors credit facilities, there is a need for suppliers to consider their 'objectives' for being in business and relate these to whether the credit risk exposure level is worthwhile. Conversely, contractors who have to competitively bid for projects have to balance project risks against potential gains (profit) from the transaction, against the potential lower bids of competitors. Evidently, this identifies that minimising risk is a dynamic continuum; being influenced by market competition. Miles and Snow's research indicates that the ability to minimise risk is achieved by 'analysers', 'defenders', 'protectors' and 'reactors' in this descending same order.

4.3.3.12 V_{MC11}: Profit maximiser

Organisations seeking to maximise profit tend to have an 'analyser' typography. Profit maximisation can be evaluated in two ways. First, if a debting organisation withholds payment from a supplier, then it follows that such monies can be invested elsewhere for improved profit. This positions 'analysers' as a higher credit risk. However, if a longer-term view is taken, maximising profit is synonymous with organisational survival (Russell and Zhai, 1996). Subsequently, in such instances, although a supplier may have to wait longer for monies owed, repayment should eventually be forthcoming. 'Analysers' are therefore positioned towards minimum credit risk in the conceptual model, this is followed by 'defenders', 'prospectors' and 'reactors'.

4.3.3.13 V_{MC12}: Cautiousness when entering new market places

Contractors exhibiting an 'analyser' typography offer minimum risk to suppliers when entering new markets. New marketplaces have to be captured so that contractors keep pace with purchasing 'fashions' of customers (clients) and hence, maintain credible cash flow. 'Analysers' consider a number of implications associated with entering the market place before making their initial move into it. New areas of business intrinsically demand new skills and talents of entrants. Failure to recognise these needs and demands will be reflected in additional unseen costs (e.g. ineffectual working). Consequently, there is a need to closely evaluate the demands of a new market place, ensuring that the contracting organisation can meet its requirements whilst remaining solvent. Unseen costs inevitably negatively influence cash flow. When incoming cash flow becomes restricted, so a similar reduction in cash outgoing occurs (Haverstock, Unknown). This means that the contractor tends to delay repayment of creditors until the last possible moment. Other typographies fail to consider the new market place's implications to such an extent as 'analysers'; therefore, in terms of credit risk 'defenders' and 'prospectors' are placed equally as hazardous, whilst 'reactors' induce greatest risk on suppliers who allow contractors credit.

4.3.3.14 V_{MC13}: Planning for efficiency and monetary control

Here, 'defenders' are the ideal typography. As with V_{MC11} this variable has two differing viewpoints. If 'defenders' are so good at planning for efficiency and monetary control, the implications are that the contractor could possibly withhold payment until the last moment. The alternative viewpoint is that 'defender contractors' will meet intended profit margins and continue to thrive. Therefore, although a supplier may have to wait a little longer for payment, the payment will be honoured in the long term. Other typographies are ranked on their monetary control and efficiency based on research produced by Miles and Snow and are shown in Figure 4.4 later.

4.3.3.15 V_{MC14}: Specialist in niche market

Two extremes need consideration here, market viability and market competition. For instance, if the market opportunity has limited duration (life) and an organisation has solely dedicated themselves to serving this demand, then it follows that as the demand desists their income will mirror this. Following from this, bankruptcy is inevitable; unless the organisation successfully diversifies. The converse situation is where an organisation holds a monopoly. In such instances, provided there is continuing demand for the product and no major management errors, organisational survival is virtually guaranteed. Contractors operating in these extremes of environment represent different risk levels to crediting organisations. Using Miles and Snow's classifications, 'defenders' offer the least credit risk, and 'reactors' the greatest risk. 'Analysers' tend to be less risky than 'prospectors', but more risky than 'defenders' in this specific aspect.

4.3.4 The model for element *M*

Having individually considered the sub-model's variables relating to item '*M*' of Formula 3.3, a graphical risk profile for a potential debting organisation may now be constructed. Figures 4.2 to 4.4 depict the literature reviewed in this chapter in the form of a risk assessment model. The model is basic, being designed only to highlight the key impacts considered. To use the model one must mark the horizontal scale of each variable; the position of which, should represent the evaluator's perception of how the potential debtor is structured, managed, developed and so on.

As a general rule, the closer the mark is to the right of the scale(s) the greater the risk element to the crediting organisation and vice-versa. The model comprises three sections, each representing the relationships and decision-making aspects (A-C) considered in this chapter.

At present, the scales are un-callibrated. This means assessment is purely subjective. This specific 'weakness' requires future research (i.e. to achieve calibration) and provide an ability to quantitatively evaluate these variables. Currently, it cannot be safely stated whether variables are linearly, quadratically, logarithmically etc. related, nor, if the variables are identically 'weighted' in importance. Despite these 'negative' aspects, the model is in conceptual terms, entirely novel. Because of this, the sub-model will use 'utility' functions to convert perceptions into quantified measures. The reason for using a utility function is that the variables considered are subjective i.e. they rely heavily on an individual's / crediting organisation's perception of the associated risks, for each variable, for a given debtor.

Figure 4.2
Part A: Contractor-supplier relationship development

Variable ↓	Risk: Low	Medium	High
V_{MA1}	*Type of Relationship* (Sako, 1992) Goodwill trust	Competence trust	Contractual trust
V_{MA2}	*Duration of Relationship* Years	Months	Days
V_{MA3}	*Product Specification* Bespoke		Standard
V_{MA4}	*Delivery Specification* Bespoke		Standard
V_{MA5}	*Cultural Difference Between Organisations* Small		Large
V_{MA6}	*Strategy & Leverage* Lots		Little

Figure 4.3
Part B: Organisational decision-making

Variable ↓	Risk: Low	Medium	High
V_{MB1}	*Number of People involved in Decision* Many		Few
V_{MB2}	*Organisational structure = Formalised machine bureaucracy* Decision to be made = Problem & incrementally orientated		Dynamic, innovative & political
V_{MB3}	*Organisational structure = Centralist simply structured* Decision to be made = Dynamic and innovative		Problem & incrementally orientated & political
V_{MB4}	*Organisational structure = Complex professional bureaucracy* Decision to be made = Political		Problem & incrementally orientated, dynamic and innovative
V_{MB5}	*Turbulent Environment* Heterogeneous team		Homogeneous team

Figure 4.4
Part C: The individual and environment

Variable ↓	Risk: Low – Medium – High
V_{MC1}	*Information available to evaluate organisation* Lots ↔ Little
V_{MC2}	*Cognitive capacity of decision making group / individual* Good ↔ Bad
V_{MC3}	*Resources available to make decision (time, money, information)* Lots ↔ Little
V_{MC4}	*Definition of goal* Definitive ↔ Non Descriptive
V_{MC5}	*Need to be: flexible, adaptive and entrepreneurial* Prospector, Analyser, Defender, Reactor
V_{MC6}	*Need to be: Exploiter of new market places* Prospector, Analyser, Defender, Reactor
V_{MC7}	*Need to have: adaptive organisational structure* Prospector, Analyser, Defender, Reactor
V_{MC8}	*Need to be: effective* Prospector, Analyser, Defender, Reactor
V_{MC9}	*Need to be: efficient* Defender, Analyser, Prospector, Reactor
V_{MC10}	*Need to : minimise risk* Analyser, Defender, Prospector, Reactor
V_{MC11}	*Need to : maximise profit* Analyser, Defender, Prospector, Reactor
V_{MC12}	*Need to : be cautious when entering new market places* Analyser, Defender / Prospector, Reactor
V_{MC13}	*Need for : Immense planning for efficiency and monetary control* Defender, Analyser, Prospector, Reactor
V_{MC14}	*Need to be : Specialist in niche market* Defender, Analyser / Prospector, Reactor

For element 'M' (Formula 3.3) the following sub-model is derived:

$$M = \sum_{i=1}^{n} X_i \qquad \text{(Formula 4.3)}$$

Where M = as per Formula 3.3; X_i denotes the n variables considered in the three (X) component parts of M. That is, the summation of the variables $(1,2,3,4,...n)$ among each of the three components (MA, MB, *and* MC) of sub-model M provides an indication of the potential supplier / contractor relationship (creditor / debtor) interaction. Hence, X_i is a function of:

$$X_i = f U\mathrm{A}_i + U\mathrm{B}_i + U\mathrm{C}_i \qquad \text{(Formula 4.4)}$$

Where: U = the utility value of components A to C measured in respect of i. Because variables included in element '*M*' of the sub-model are 'measured', based on suppliers' individual perceptions of a potential debtor, utility functions are used: hence the representation via '*U*' in Formula 4.4. In that X_i consists of many sub-variables, then:

$$X_i = f(v_{xi}) \qquad \text{(Formula 4.5)}$$

Where: v_{xi} are objective variable functions of X_i.

Formula 4.5 means that the 'value' of the sub functions (v_{xi}) are elements of X_i, so the 'physical' value assigned v_{xi} has an influence on X_i. That is, v_{xi} ε, and function, of X_i. To consider it another way, (v_{xi}) are utility functions attributable to X_i, being derived from transposing 'natural' non-tangible aspects into utility values on a scale ranging from zero to one (i.e. 1.0 = maximum utility). From Formula 4.5 a further assumption can be made, this being that the summation of the variables (v_{xi})

considered in each of the sub-variables (*M*A, *M*B, *and M*C) respectively, provides an indication of the supplier/contractor (potential) relationship 'strength'. Hence:

$$X_i = \sum_{i=1}^{n} v_{xi} \qquad \text{(Formula 4.6)}$$

Because v_{xi} range from 0.0 to 1.0, transposition of Formula 4.6 can be made to permit each of the 'main' variables (*M*A, *M*B, *and M*C) to have a range between 0.0 and 1.0. This is achieved by Formula 4.7; viz:

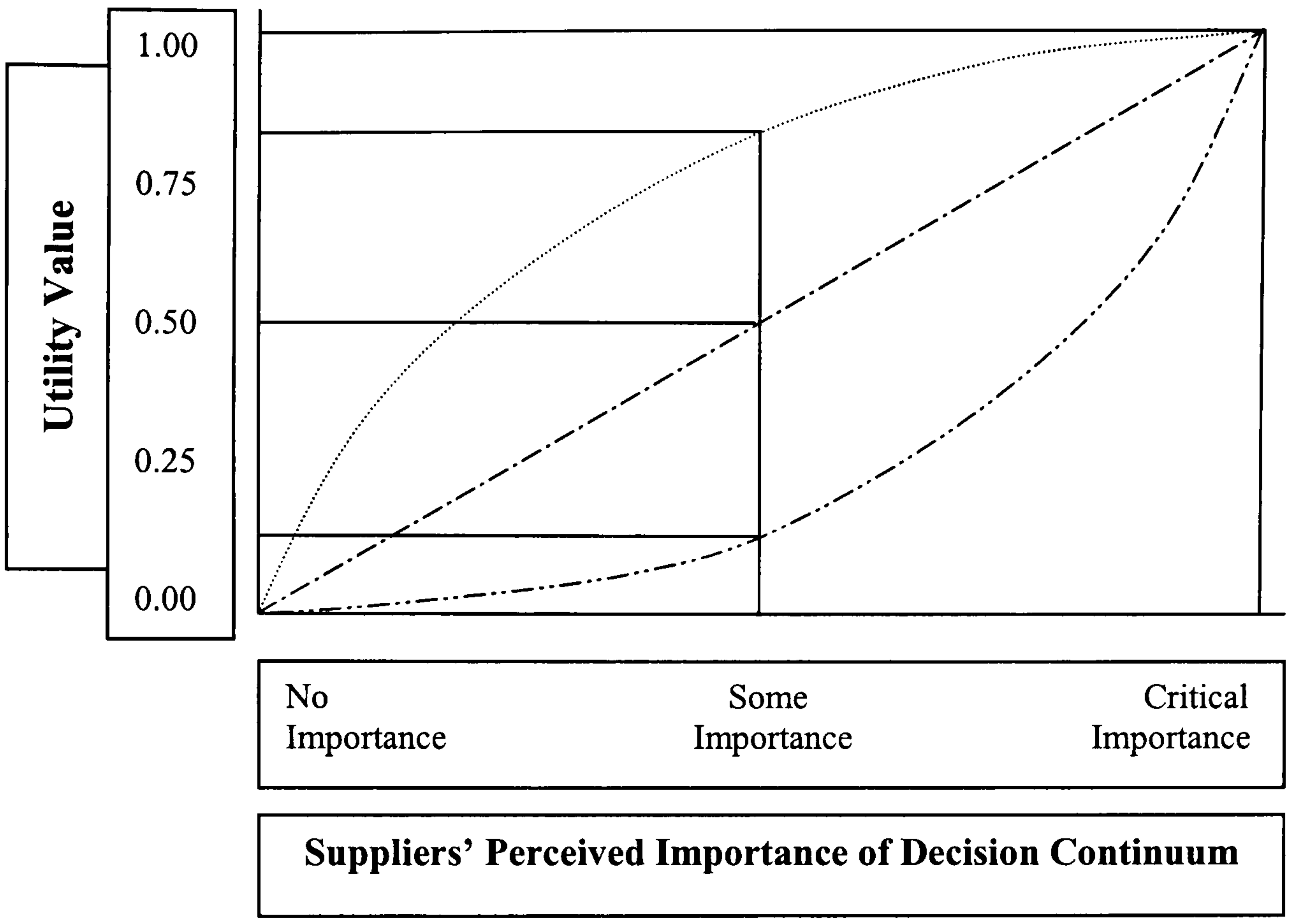
$$\frac{\Sigma X_i}{n} \leq 1.0 \qquad \text{(Formula 4.7)}$$

Where: X_i = the group of i variables associated with any one component of sub-model *M* (i.e. *M*A, *M*B, or *M*C). Formula 4.7 allows suppliers to obtain a 'standardised' measure of a potential debtor's characteristics, so that reasons for granting credit (or not) can be measured and interpreted independently. This information may be useful for informing contractors *why* they were not allowed credit. It may also be useful to assist credit control departments in defending their decision not to recommend a contractor for being allowed credit. Finally, it will highlight the contractor who achieves a 'good' overall score for *M*, but exhibits poor characteristics in any one of the sub-components *M*A, *M*B or *M*C.

In all, the sub-model presented in this chapter allows suppliers (creditors) a numerically based method for evaluating certain characteristics of a potential debtor (contractor) to identify whether the contractor is 'worthy' of being allowed materials on credit. The evaluation of the characteristics described in this chapter can be used to derive whether the evaluated characteristics of the potential debtor are conducive to a creditor defining the potential debtor as 'creditworthy', or not. Essentially, the characteristics concentrated upon are those that need scrutiny when evaluating whether the risk associated with the contractor / supplier relationship is within the supplier's allowable risk tolerance level.

Having presented the 'theoretical' and 'mathematical' elements of the variables associated with generic item M of Formula 3.3, it is now necessary to relate these elements into a user (supplier) friendly composite. However, as has been previously mentioned in this chapter, (and in Chapter 3 where the definition of creditworthiness for this thesis is first mentioned), suppliers' perception of risk will influence whether the supplier / contractor interaction is perceived as 'creditworthy'. Because of this 'individual supplier characteristic' (perception) there is a need to also consider whether the supplier making such evaluation is risk averse, risk neutral or risk seeking. The reason for defining the risk-taking characteristics of a supplier in this way, is because different levels (values) of utility will be obtained for variables in generic item M, by different risk-taking suppliers. It is shown in Figure 4.5, that the risk taking characteristics of a supplier has a large influence on the evaluation of a potential debtor.

Figure 4.5
Risk characteristics of supplier and the influence on decision-making



·························· denotes risk seeking utility curve
—·—·—·— denotes risk neutral line
—··—··—· denotes risk averse curve

(Adapted from Holt, et al., 1994)

With reference to Figure 4.5, and using an example of three different suppliers who value a certain decision as having 'some' perceived level of importance, it can be seen that the supplier with a risk averse characteristic would assign the decision as having a utility value of 0.13; a risk neutral supplier would 'value' the same decision with a level of importance as 0.50; whilst a risk seeking supplier would value the decision as 0.85. By considering suppliers' risk taking characteristics in this way, the sub-model now becomes dynamic (see Holt, et al., 1994). Hence, via the knowledge the supplier has of their own organisation's risk-taking characteristics, it is possible for the supplier to identify an 'importance' value regarding the characteristics of a potential debtor. For example, if a certain characteristic is perceived by a supplier as being key in the evaluation of a contractor's creditworthiness, then the utility value of this one characteristic will be assigned a greater degree of importance than compared to other, less important (perceived) characteristics.

Obviously, due to 'perception' of suppliers being used in the context of evaluating an 'importance' rating for individual variables that have been mentioned in this chapter, the sub-model (generic element *M*) is designed to allow the individual managerial characteristics of both creditor (supplier) and potential debtor (contractor) to be modelled. By achieving this, it is possible to identify whether the supplier is going to be exposed to financial risk in excess of their tolerable risk threshold when (and if) they furnish the contractor being evaluated with credit.

When questioning '*how*' suppliers make a decision regarding contractors' managerial characteristics and organisational structure (such as those variables considered in this chapter), it is evident that there are a considerable number of observations to be made. Because contractor creditworthiness evaluation is stymied (by suppliers) with being highly restricted in resources allocation (Chapter 7); evaluation of contractor creditworthiness using the sub-model derived in this chapter has to be realistically employable within such constraints, if it is to gain mass usage. Hence, there is a need for 'everyday' operations of a supplier to be used and / or slightly manipulated so that the variables detailed in this chapter can be 'measured'. For instance, sales representatives when visiting a contractor who has, or is going (potentially) to be furnished with credit, should observe working practices of *everyone* that they meet at the contractor's organisation. By making such observations it could be deduced if there is an organisational hierarchy present, whether the operatives in the organisation give the impression of being motivated in their work, and so on. Sales representatives could also gather information regarding whether the contractor desires a long-term business relationship with the supplier (or not). Sales representative(s) personal contact with a contractor who has credit facilities with the supplier, or who is seeking credit for the first time, cannot be understated. Indeed, many of the variables detailed in this chapter are particularly suitable for evaluation by people from a supplier's organisation who have personal contact with the contractor whose creditworthiness is being evaluated.

The knowledge of a supplier's sales department, who deals with contractor materials orders, can also be used for evaluation of contractors' characteristics that have been detailed in this chapter. For example, by monitoring the ordering of materials and delivery criteria asked for by a contractor (who already has credit), the supplier's sales department can gain knowledge of a contractor's characteristics. That is: has the contractor the ability to pre-plan materials needs for future work?, or are special 'next day' delivery demands being continually asked for?; what their workload is at that point in time?, and how does this fluctuate based on seasonal influences and the prosperity of the economic climate (etc.)? Factors like these can all be used to build the creditworthiness profile of a contractor who has, or is potentially going to be, offered credit facilities.

Observations such as those mentioned, all have the ability to indicate to a supplier the degree of financial risk that they expose themselves to. Because of the 'value' of these observations, it should be made explicit to *all* supplier personnel who have contact with contractors, who want (or already have) credit, that any 'information' they can gather on the contractors' characteristic are worthy of 'modelling' for the purpose of financial credit risk evaluation.

Evidently, if a number of different people from a supplier's organisation are compiling information on a potential, or actual debtor's characteristics, then there is a need for this information to be 'filed' in one specific location. This is so that 'physically' collecting the relevant data consumes only minimal resources. Possibly the use of the supplier's Intranet computer system may be an ideal tool where contractor characteristics could be stored. Subsequently, from this gathered information, a supplier's management could make a decision whether to grant credit, and to what level (credit limit). Yet again, the comments made in these last paragraphs are potential areas for future research, which are beyond the realms of this current research project.

Having presented a model that evaluates element M of Formula 3.3, the research now moves on to concentrate on generic element E.

4.4 ELEMENT *E*: EXTERNAL MACROECONOMIC CLIMATE AND ASSOCIATED BANKRUPTCY LEVELS

Bad debt resulting from construction contractors' insolvency is a significant risk to suppliers. In attempting to assess such contractor credit risk, there is a need to incorporate factors relating to macroeconomics. This section of the chapter presents a regression model for predicting macro levels of English and Welsh construction company insolvency through consideration of macroeconomic indicators. Contractor insolvency for Scotland and Ireland are ignored from this statistical analysis, because of data incompatibility. That is, England and Wales insolvency data is only available from the Department of Trade and Industry, whilst Scottish and Irish insolvency data is only available from these respective countries' Trade and Industry departments. Hence, there tends to be disparity between these insolvency classification techniques, meaning that summating the representative insolvency numbers would result in data incompatibility. This lack of uniformity (variance) in the dependent variable (contractor insolvency numbers), would prove unreliable in any regression model.

The technique of regression was selected for this modelling task because it had the ability to estimate the time value (number size) of the dependent variable (contractor insolvencies), based on observations of 'other' independent variables (Oltman and Lackritz, 1991 p.498). The analysis presented confirms that construction contractor insolvency rates are highly related to:

i. volume of brick deliveries to 'all' construction ;
ii. the construction materials price index for housing; and
iii. the volume of sand and gavel sales.

Transpositions (detailed later) were performed on these factors, in order to optimise analysis. To utilise the developed regression model to its best ability, crediting organisations (suppliers) should trend these indicators (volume of brick deliveries;

the construction materials price index for housing; and the volume of sand and gavel sales) in attempting to mitigate future financial risk exposure.

4.4.1 Background

Previous research has identified that assessment of credit risk to materials suppliers should consider the holistic nature of the business environment; as well as the financial and management principles by which construction contractors operate. By considering environmental (business) factors relating to insolvency of English and Welsh construction contractors, it is envisaged that a greater understanding of the risk that materials suppliers expose themselves to when they furnish contractors with credit will be gained.

The fundamental catalyst for this chapter is as follows: If there are links between economic factors and the total number of English and Welsh construction contractor insolvencies, then these need to be highlighted and understood. There are several reasons for this. First, movements in these economic factors (to be detailed later) will act as indicator(s) of future contractor demand and general 'economic health'. Further, these indicator(s) could be used as predictors of future construction industry workload and concurrently therefore, as predictors for signifying the risk of contractors' potential for failure (insolvency). Finally, the factors identified as being statistically significant in predicting contractor insolvency levels, may assist in determining maximum credit limits for contractors. Regarding the latter, it has previously been suggested that credit limits should be a function of economic 'buoyancy' at a given time (and in the near future, i.e. next accounting year) (op. cit.).

In summary, this section of the chapter concentrates upon construction industry contractors and their creditworthiness. It investigates the link between levels of English and Welsh construction contractors' insolvency, and economic factors such as UK construction materials price indices and the construction industry's demand for construction materials.

Prediction of insolvency, for various sectors of industry, has received previous research attention (e.g. Deakin, 1976; Altman, 1976 and 1993; Mason and Harris, 1979; Taffler, 1995; Russel, et al., 1996; Lowe, 1997a). However, many of the models resulting from this research, utilise input factors that are difficult and / or costly to obtain by suppliers. Since this section of the chapter is primarily concerned with evaluating (contractor) credit risk for materials suppliers, input factors must be easily and economically obtainable (Holt, et al., 1994). Hence, to enable suppliers to gain information which does not result in excessive resource consumption, there is a need to maintain a close 'proximity' between the working environment that materials suppliers are exposed to on a daily basis (input factors), and construction contractors' survival / insolvency rates (credit risk).

When discussing contractor insolvency, relationships between different organisations within the business economy must be considered. The reason for this is as follows. Construction involves a number of different organisations of varying characteristics; such as size, technological advancement, financial structure, management capability and corporate configuration (Chapter 2). The resultant effect upon each organisation when another in the 'chain' fails (becomes insolvent), is a transfer of (financial) debt.

Lowe (1997a p.88) suggested that failure of one firm interacting with the construction industry may in turn, result in the insolvency of another; thus highlighting the need for future research into the 'domino effect' of company insolvencies.

4.4.2 Methodology of insolvency prediction

Economic principles imply that society will, ultimately, decide how much, when and what to manufacture (Begg, et al., 1991 p.2). Furthermore, society will directly and indirectly, dictate the amount of money they are prepared to pay for a service or product. The interactions of these principles form the notion of supply and demand. As demand varies so does the price of a consumer product, and vice versa. It subsequently follows that cost and delivery quantities of construction materials will fluctuate depending upon the economic climate at a specific point in time, or in the future, depending upon lead-in times associated with construction logistics.

The price fluctuation of materials aims to find the point of equilibrium between the industry's needs (material demand) and the price that is willing to be paid. To analyse links between economic factors and construction company insolvency levels, this section of the chapter consulted quarterly statistical records at two yearly intervals for the period 1970 to 1995 (inclusive). These statistical records included: The Annual Abstract of Statistics (various); and Housing and Construction Statistics (various). From these records, a database of quarterly statistical measures was compiled. When using statistical records in this way there are caveats requiring consideration. For example, one must be aware that the criteria for calculating construction materials price indices has changed over time. In short, constant consideration needs to be given to the source and accuracy of such data.

The data considered (for the period observed) also facilitated observation of economic trends and their simultaneous reaction, movement and fluctuations under both Labour and Conservative governments.

4.4.3 Factors considered

Since materials suppliers' prime function is to provide building products to construction contractors, evaluation of contractors' creditworthiness is a supplementary, yet essential task *if the supplier is to offer credit facilities within a tolerable risk level.* Factors to be included in contractor creditworthiness evaluation procedures must not result in excessive resource consumption; otherwise the model will be rejected by those it is intended to help. To support this statement, part of a survey of methods presently used by UK materials suppliers for contractor creditworthiness evaluation, identified that resource consumption averages under one hour and costs less than fifty pounds; per contractor evaluated (Chapter 7). Within these constraints, seven factors were selected as being 'easily' and 'economically' obtainable, and 'measurable' by materials suppliers. A further fifteen factors were obtained for each 'prime' variable. These 'other' variables were obtained by carrying out mathematical transformations on the 'prime date'. The seven principal factors were:

i. Construction contractor insolvencies (designated *a*); the number of construction companies declared insolvent. For the analysis presented, this is the dependent factor.

ii. Ready Mixed Concrete (designated *b*); denotes the amount of ready mixed concrete produced in a specific quarter, measured in thousand cubic metres.

iii. Brick deliveries (designated *c*); denotes the total number of bricks (facing, common and engineering), delivered to customers by the end of a given quarter.

iv. Block deliveries (designated *d*); denotes the total thousand square metreage of blocks (dense concrete, aerated concrete and lightweight concrete combined), delivered to customers by the end of a given quarter.

v. Sand and Gravel (designated *e*); denotes the total sales of sand and gravel measured in thousands of tonnes delivered, per quarter.

vi. Construction materials price index for housing (designated *f*).

vii. Construction materials price index for all types of construction (designated *g*).

Before performing analyses on these raw data, transpositions were performed. The purpose of transformation is defined by Frees (1996 p.421) as:

'rescaling the data'

Chaterjee and Price (1977 p.38) and Brook and Arnold (1985 pp.91-3) list a number of advantages to be gained from transposing data for the purposes of applying multiple regression techniques to them. These are:

- stabilising variance;
- reducing the impact of outliers; and
- gaining factors that are 'more' normally distributed and linear in characteristic.

Transpositions were performed to allow an in depth investigation between the dependant and independent factors, when using regression techniques. A full list of those transpositions performed and respective identification numbers (for the various transpositions) are exhibited in Table 4.1.

Table 4.1
Transpositions performed and respective identification numbers

Transposition method	Identification Number
Natural log	1
Exponential	2
Lagging data by one quarter of a year	3
Lagging data by two quarters of a year	4
Lagging data by three quarters of a year	5
Lagging data by four quarters of a year	6
Differencing the data once	7
Differencing the data twice	8
Differencing the data thrice	9
Differencing the data four times	10
Inverse of data	11
The exponential of the prime data multiplied by 10-3 i.e. *Transposition 12 = exponential (prime data / 10^3)*	12
The four point centred moving average of the factor	13
The cumulative actual figure for the factor	14
The cumulative four point centred moving average of the factor	15

The identification letters for factors, and transposition numbers, (given hereafter in parenthesis) are used for acronym of the data for brevity. For example, *c3* indicates the total number of bricks delivered in a quarter (*c*), lagged by one-quarter (*3*). These acronyms should be noted because they are referred to throughout the following text. A total of 112 factors were initially considered in this analysis. That is, the 15 transformations were performed on each prime factor as well as using the prime factor itself i.e. sixteen data sets were considered for each prime factor *(16 x 7 = 112)*.

The following section explains the mathematical underpinnings of obtaining certain transposed variables. Transpositions relating to natural log and exponential are excluded from this explanation, because it is assumed that the reader has basic mathematical knowledge in these domains.

Lagging: to best explain this transformation, an example is shown in Figure 4.6.

Figure 4.6
Calculating a time lagged factor

Time (quarterly yearly data)	Original variables	One quarter time lagged variables	Two quarters time lagged variables
t=1	5	8	9
t=2	8	9	4
t=3	9	4	2
t=4	4	2	3
t=5	2	3	
t=6	3		

From Figure 4.6, to lag a factor by one quarter requires removing the first original variable numeric and starting the 'lagged variable' with the second of the originally listed variables. That is, the lagged variables are 'moved up' one time period, and the first variable removed. This process continues progressively until the desired number of lags has been incorporated into the data.

Differencing: this involves observing the difference in the original variables between one quarter and the next. Again, by using illustrative figures the mathematical construction of a differenced factor is easily seen (Figure 4.7).

Figure 4.7
Obtaining a difference factor

Time	Original variables	First Differenced Variable Calculation	First Differenced Variable
$t = 1$	5	$8 - 5 = 3$	3
$t = 2$	8	$9 - 8 = 1$	1
$t = 3$	9	$4 - 9 = -5$	-5
$t = 4$	4	$2 - 4 = -2$	-2
$t = 5$	2	$3 - 2 = 1$	1
$t = 6$	3		

Having obtained the first differenced variable it is then possible to determine the second, third and fourth differenced variables as required.

Four Point Centred Moving Average: As with differencing and lagging of data, to explain the calculations involved in deriving a four point centred moving average variable, it is most easily achieved via a worked example (Figure 4.8).

Figure 4.8
Calculation of a four point centred moving average variable

Time	Original Variables	Four Point Moving Average Calculation	Four Point Centred Moving Average
$t = 1$	5		
$t = 2$	8	$= (5 + 8 + 9 + 4) / 4 = 6.5$	
$t = 3$	9	$= (8 + 9 + 4 + 2) / 4 = 5.75$	$= (6.5 + 5.75) / 2 = 6.125$
$t = 4$	4	$= (9 + 4 + 2 + 3) / 4 = 4.5$	$= (5.75 + 4.5) / 2 = 5.125$
$t = 5$	2		
$t = 6$	3		

From Figure 4.8 it can be seen that the average value of four consecutive original variables are summated and then divided by four to produce an average. Since this calculation provides the average of period 2.5, 3.5, 4.5 and so on, the final column of Figure 4.8 summates the two consecutive calculated four point moving average and finds the average of these averages.

4.4.4 Prediction of contractor insolvency

Notwithstanding its macroeconomic connections, this section of the chapter's emphasis is on predicting contractor insolvency for the purpose of evaluating the level of credit risk that contractors impose on materials suppliers (when they are furnished credit). By predicting contractor insolvency levels, creditors can adjust their methods of analysing contractor creditworthiness risk in relation to the present, or predicted economic climate. For example, if it is forecast that a considerable number of companies will become insolvent in the near future, then the risk level to suppliers is increased; obviously, more so than were the converse predicted. This assumes that all other factors remain constant (e.g. no change in contractors' management philosophy towards payment for goods). This latter caveat is important, because during a recession, cash flow becomes a higher priority than profit (Brett, 1991).

In that suppliers are not recognised as 'secured' or 'preferential' creditors, the implications for them when a contractor defaults on payment (or worse, becomes insolvent) is directly related to the supplier's own financial well being; indeed survival. Subsequently, if it is possible to predict, in macro terms, the probability of contractor (debtor) failure, then the implications for crediting organisations are obvious i.e. the supplier can take actions to reduce their level of financial exposure. Because bad debt has to be counteracted by an upward adjustment in overheads (e.g. upon materials prices), so bad debt reduction (tentatively) relates to increased profit margins (less need to reduce profit margins to remain competitive with other materials suppliers). It also leads to improved competitiveness (less need to make allowance in price of materials sold to counteract bad debt), and increased client satisfaction (the client will tend to be 'happier' purchasing materials at a lower price than compared to the price that 'other' materials suppliers are charging for the same item[s]). In all, suppliers ability to accurately forecast the level of construction contractor insolvencies will (potentially) provide the supplier with an indication of their present potential bad debt risk exposure level.

4.4.4.1 Methodology for predicting insolvency

Ideally, 'present day' data would be available regarding construction contractor insolvencies. However, time and resource constraints mean data is always 'out of date' and often limited in its frequency. Subsequently, there is a need for predicting future economic occurrences, based on what has gone before, so that organisations can modify their actions to ensure risk is kept within allowable tolerances. For materials suppliers, who furnish contractors with credit, it is evident that there is a need to maintain potential debt risk within allowable tolerances. By producing a regression model for predicting contractor insolvency levels, suppliers should be able to gauge their potential financial risk exposure levels, with respect to fluctuating contractor insolvency levels, with a greater degree of accuracy than compared to not having such knowledge at their disposal. It should however, be borne in mind that it is not always essential to minimise risk. The objective in business is to *identify risk, price it and sell it*. Hence, within the context of this thesis's, the final decision to grant credit must ultimately lie with the materials supplier, for whom the risk will be perceived as a worthwhile investment, or otherwise!

Construction contractor insolvency prediction will never be 100 per cent accurate due to 'noise' within the derived model and / or noise in the independent variables. Because of this noise an error correction term is required in any prediction model; viz.:

$$\begin{matrix}\textit{Number of Contractor} \\ \textit{Insolvencies}\end{matrix} = \begin{matrix}\textit{Forecast} \\ \textit{(via economic factors)}\end{matrix} + \textit{error in forecast} \qquad \text{(Formula 4.8)}$$

The aim is (of course) to minimise 'error' at all times, so that the forecast is of highest accuracy. However, since there is a cost associated with obtaining information, a trade-off has to be made between the resources consumed obtaining 'perfect' information and the benefits of obtaining 'less than perfect information'. That is: 'is there a sufficient return on the resources consumed to warrant such expenditure and similarly, does the accuracy (and actions) resulting from having this information justify its expense?' Again, future research is required to definitively answer this question.

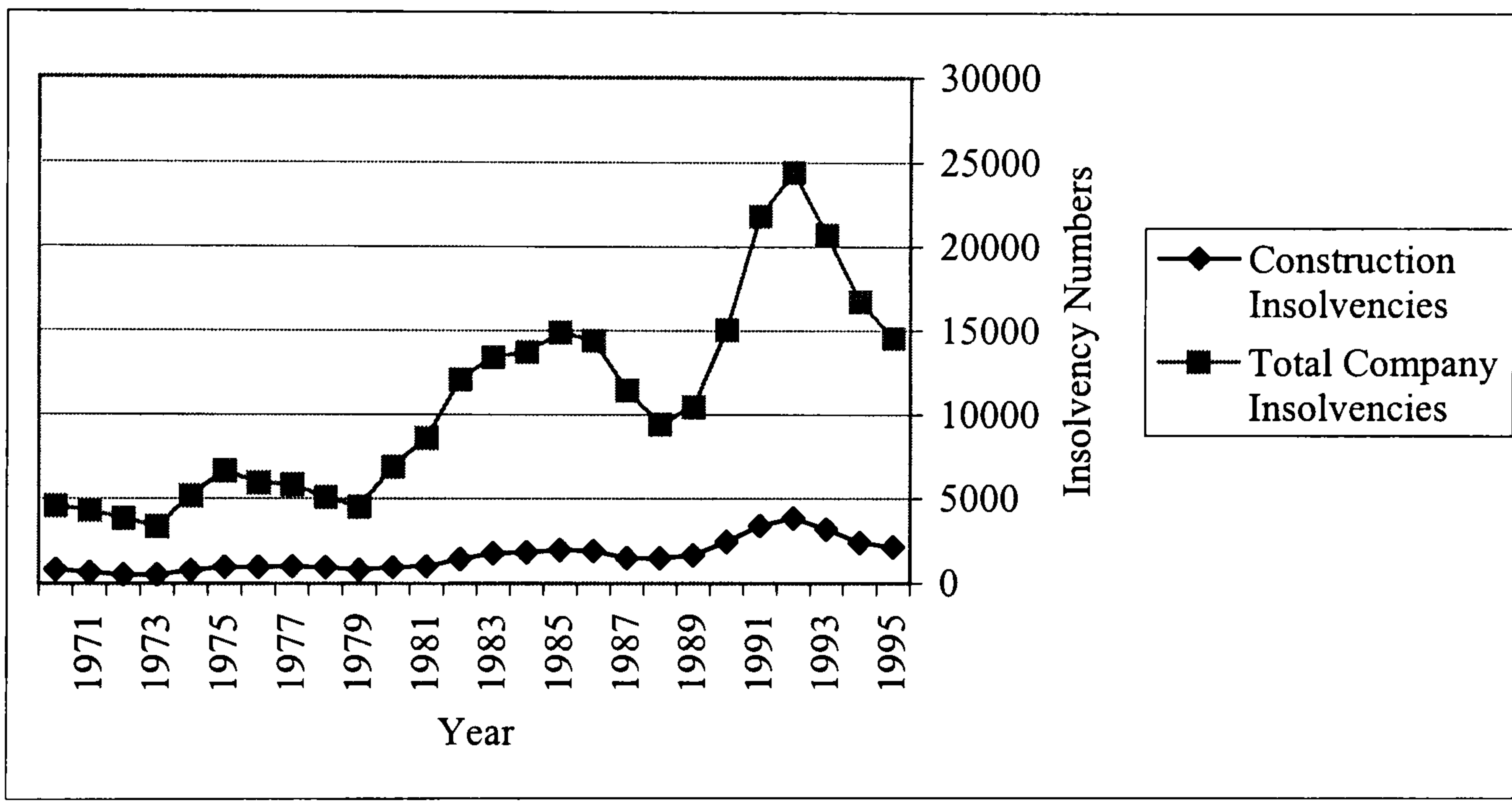
4.4.4.2 Estimation of error methodology

Contractor insolvency is not an isolated occurrence, so analysis of contractor insolvency trends and volatility, in isolation, would prove an inadequate form of prediction in itself. Therefore, relationships between the total number of insolvencies and other factors must be considered. For this chapter, those factors which will be 'modelled' have been detailed previously in the chapter. The factors have been selected for use in this analysis because they relate to everyday 'hands-on' materials, the volumes of sales for which, the majority of suppliers should be able to easily monitor.

Primary analysis of construction contractor insolvency levels identifies a cyclical pattern with a gradually increasing number of insolvencies per year (see Figure 4.9) (see further Oltman and Lackritz, 1991 pp.634-5). The upward trend reflects a gradually increasing number of companies and contractor insolvencies. Figure 4.9 shows that insolvencies in both the general business environment and the construction industry, have increased at an approximately constant rate throughout the period investigated (apart from periods of recession). It can also be deduced that the number of contractor insolvencies accurately mirrors the broader business 'prosperity' (the number of insolvencies in the English and Welsh business environment). This statement is based on the knowledge that the UK was in recession during the late 1980's and early 1990's and that the insolvency trend during this period significantly changed from that which had gone before (Lowe, 1997a). Also noticeable from Figure 4.9, is that since the period investigated spans UK governance by two different political parties (Labour and Conservartive), insolvencies have followed a relatively constant trend despite such political changes. There seems no need on a macro level therefore, to deduce any 'weighting' to political governance in respect of insolvency frequency.

Finally, it can be seen that the total number of construction contractor insolvencies mirrors very closely the trend for overall company insolvency for England and Wales (correlation coefficient of 0.98). Thus, a formula for predicting construction contractor insolvency might also be used with some accuracy, in predicting overall company insolvency for England and Wales, and vice-versa.

Figure 4.9
Company insolvency levels in England and Wales



Following observation of insolvency trends, the interactions of previously mentioned economic factors with respect to construction contractor insolvencies are now investigated.

4.4.4.3 Prediction of contractor insolvency using multiple regression techniques

Contractor insolvency is a causal interaction (output dependant upon the input of many factors), so the relationships between actual and predicted insolvency figures can be investigated and modelled utilising statistical computer software. For this thesis chapter, the stepwise regression abilities of SPSS version 8 were used. A comprehensive description of the methods used in stepwise variable selection is given in Chapter 8. A number of regressions were performed using various dependent variable transpositions (as detailed earlier), the most statistically significant regression model identified was:

$$a15 = 3270.013\ constant + (0.409c15) + (77.182f10) + (-0.293e7) + (-0.148e3) \qquad \text{(Formula 4.9)}$$

From Formula 4.9 it was deduced that:

i. the cumulative four point centre moving average of brick deliveries (*c15*);
ii. the differencing of four quarters on data relating to construction materials price index for housing (*f10*);
iii. differencing data related to sand and gravel deliveries by one quarter (*e7*) and;
iv. by lagging sand and gravel deliveries by one quarter of a year (*e3*).

Produce statistically significant estimation of the cumulative four point centre moving average relating to construction industry contractor insolvencies (*a15*). Formula 4.9 produces an R^2 value of 0.99 and an F statistic of 877.07. The initial conclusion here is that Formula 4.9 provides a very good estimator of construction contractor insolvency. The R^2 figure relates to the regression sum of squares divided by the total sum of squares. The total sum of squares calculation referred to is defined via Formula 4.10, viz.:

$$TotalSS = \sum_{i=1}^{n} (Y_i - \overline{Y})^2 \qquad \text{(Formula 4.10)}$$

Where Y_i relates to the value of the dependent variable at point $_i$; whilst $\overline{Y}$ denotes the average value of Y group. Similarly, the regression sum of squares is calculated by using Formula 4.10, but replacing Y_i with $\hat{Y}_i$, the latter representing the regression estimated value of Y at interval $_i$. Essentially, the sum of squares calculation allows observations to be made with respect to estimated average values of variables. From this discussion on sums of squares it is evident that R^2 figures close to one indicate the regression equation has the ability to classify the dependent variable more accurately than compared to a regression formula having an R^2 value closer to zero. In sum, the R^2 value represents the percentage of movement in $\hat{Y}$, attributable to simultaneous movements in the dependent variables. Consideration is now given to the F statistic of the regression model (Formula 4.9). The F statistic is derived by Formula 4.11.

$$F = \frac{regressionMS}{residualMS} = \frac{\dfrac{\sum(\hat{Y} - \overline{Y})^2}{K}}{\dfrac{\sum(Y - \hat{Y})^2}{n-1-K}} \qquad \text{(Formula 4.11)}$$

Where MS denotes mean square. $\hat{Y}$ denotes the predicted value of the dependent variable (contractor insolvency); $\overline{Y}$ denotes the mean value of the dependent variable; K denotes the number of independent variables used in the regression equation; and n denotes the number of observations in the dependent and independent samples.

The F statistic produced by Formula 4.9 of 877.07, when compared to F statistic tables, confirms that the regression formula is statistically significant and worthy of further consideration. Residual analysis performed on Formula 4.9 is now discussed.

The Durbin-Watson (DW) statistic identifies the first-order autocorrelation function in the residuals. Autocorrelation is the correlation of the values of series with the values lagged by one case (Frees, 1996). That is, the linear relationship between Y_t and Y_{t-1} is observed (ibid.). The formula for deriving a Durbin-Watson statistic is:

$$DW = \frac{\sum_{t=2}^{T}(\hat{e}^2_t + \hat{e}_{t-1} - 2\hat{e}_t\hat{e}_{t-1})}{\sum_{t=1}^{T}\hat{e}^2_t} \qquad \text{(Formula 4.12)}$$

Where T denotes total time of observations under consideration; t denotes relative time periods in the data observed; and $\hat{e}$ denotes the residual from the linear regression model at a particular time. Based on the first lagged correlation of the residuals, the Durbin-Watson statistic can lie between the extremes of 0 and 4 and ideally should have a mean of 2 (Brook and Arnold, 1985 pp.44-5). For Formula 4.9 the DW statistic is 2.25, confirming significantly low autocorrelation between the independent factors. Brook and Arnold (ibid.) stated that the smallest level of autocorrelation between the factors gives a good indication that the regression model will 'perform' well, i.e. with small differences between predicted ($\hat{Y}$) and actual (Y) values. Based on this statistical test, the potential predictive accuracy of Formula 4.9 is again shown.

For Formula 4.9, the following statistics were obtained from analysis of variation:

- Regression sum of the squares = 3.88 E+09
- Residual sum of the squares = 26530843
- Regression mean square = 9.7 E+08
- Residual mean square = 1105451.8

These figures confirm that the regression model accounts for a significantly large portion of the variance in the dependent variable. This statement is based on the knowledge that the figures relating to the 'regression' statistics (regression sum of the squares and regression mean square) are significantly larger than the 'residual' statistics (residual sum of the squares and residual mean square).

A series of independent variable t-tests were used to identify if factors identified in the regression model (Formula 4.9) contributed significantly (at the 95 percent significance level) to the prediction of contractor insolvency (see further Oltman and Lackritz, 1991 pp.594-596; Frees, 1996 p.85-89). It is necessary to test for independent variables' ability to predict the dependent variable, because this indicates which predictor variables are most powerful in identifying characteristics of the dependent variable when the regression formula is used (Formula 4.9). From the results of t-tests it was possible to identify which variables should have resources assigned to them, so that resources could be spent on collecting data that specifically adds towards the predictive accuracy of the regression model. The t-test results confirmed that all factors included in the regression model (Formula 4.9) are statistically significant at the ninety-five per cent significance level. Table 4.2 details characteristics of Formula 4.9 with respect to t-test results and respective significance levels.

Table 4.2
Results of t-tests for regression formula 4.9

Variable	*t-value*	*Significance*
c15	38.122	0.000
f10	3.969	0.001
e7	-3.683	0.001
e3	-2.088	0.048

Table 4.3 details model correlation and variance inflation factors (VIF). Variance inflation factors capture the complex relationship between the independent variables (Frees, 1996 p.273). By analysing the characteristics of the independent variables, with respect to their linear relationships, VIFs check for collinearity. Collinearity is when a linear (or near linear) relationship exists between one independent variable and a combination of the other independent variables (Frees, 1996 p.272). No significant level of correlation between the independent factors was evident. The correlations remain significantly small, thereby indicating little relationship between the variances of factors. Frees (1996 pp.272-273) considered the influences of collinearity and summarised viz.:

i. high correlation of independent variables does not prevent a regression model from producing 'good' predictions;
ii. tests for model adequacy and estimates of error variances are still valid; and

iii. collinearity can magnify the standard error of individual regression coefficients.

Chatterjee and Price (1991 p.191) and Frees (1996 p.274) stated that VIF values in excess of ten often signal the data has multicollinearity problems. Since this is not the case with variables used in Formula 4.9, collinearity does not negatively impact on the accuracy of forecast figures of contractor insolvency levels.

Table 4.3
Correlation and VIFs for factors in formula 4.9

	Correlation				*VIF*
Factor	*c15*	*f10*	*e7*	*e3*	
c15	1.000				2.114
f10	-0.441	1.000			1.628
e7	0.200	-0.357	1.000		1.384
e3	0.576	-0.053	0.350	1.000	1.950

Having identified that Formula 4.9 has acceptable statistical characteristics it is necessary to investigate if its performance measurement is of sufficient accuracy. For this investigation two measures were taken: the mean percentage error (*MPE*) and mean absolute deviation (*MAD*).

Mean percentage error (*MPE*) is defined viz.:

$$MPE = \sum_{i=1}^{n} \frac{Y_i - \hat{Y}_i}{Y_i} x100\% \qquad \text{(Formula 4.13)}$$

Mean absolute deviation (*MAD*) is derived from the formula:

$$MAD = \frac{\sum_{i=1}^{n} Y_i - \hat{Y}_i}{n}$$ (Formula 4.14)

For both formulae, Y_i denotes actual contractor insolvency figures for period i; $\hat{Y}i$ denotes forecast insolvency figures for period i and n denotes the number of observations taken.

For Formula 4.9 *MPE* = -8.06 per cent whilst *MAD* = -850.12. Though the *MAD* figure seems initially high it has to be considered in relation to the dependant factor's numeric. As the dependant variable (contractor insolvency) is a cumulative summation of construction contractors' insolvency numbers, these figures are large (approaching 40,000). When the *MAD* figure is compared to the average of the summation of the dependant factor an average *MAD* is derived at –5.79 per cent per observation. Both *MPE* and *MAD* identify that Formula 4.9 performs well in relation to predicting contractor insolvency numbers.

4.4.5 Discussion of regression findings

The regression model identified that: brick deliveries; the construction materials price index for housing; sand and gravel sales; and transpositions performed on these factors are good indicators of the cumulative four point centred moving average of construction contractor insolvency numbers.

Since the construction industry operates in a highly fluctuating market (for both demand of goods and prices charged for such), the predictor factors in the regression model are to some extent expected, albeit their modelling in this way is novel. That is, it would be unreasonable for demand of building materials to remain constant when the demand for construction work declines. In turn, this fluctuation will influence the cost that contractors are willing to pay for such materials. The laws of supply and demand and the price equilibrium mechanism do therefore operate in relation to the regression model presented. Fluctuations in demand and costs of the predictor variables, identifies a direct relationship between the workload of the construction industry and associated insolvency levels of contractors.

Having already assessed the prediction performance of Formula 4.9, model restrictions, model noise and the impacts upon materials suppliers (crediting organisations), credit risk is now discussed.

4.4.5.1 Practical restrictions of regression model

Formula 4.9 has limitations. The formula relies in part upon the construction materials price indices for housing works. This index is calculated via a weighting applied to certain materials contained within Table 2 of the Housing and Construction Statistics publication (various dates). Caveat: Materials used in the indices are reassessed as to their relative importance in depicting the overall cost of construction materials. Since materials selected for inclusion in the indices have to reflect current demand in building practice, thought needs to be given as to which materials, should be monitored in this context.

Accurate usage of Formula 4.9 necessitates the utilisation of macro figures in relation to total bricks, and sand and gravel deliveries per quarter. Because up-to-date information of this kind is not readily available, materials suppliers should carry out 'self-monitoring' if the model is to be used. 'Self-monitoring' records of such sales in this context is a process whereby suppliers constantly monitor, (e.g.) the number of bricks delivered to site by their organisation and / or the representative number of brick quotations supplied. Then, not only can a judgement be made against how successful the supplier is at winning orders, but also, this would indicate their proportion of market share and fluctuations due to increased competition and changes in market demand. From this, suppliers could estimate macro sales of bricks.

The second problematical area for using Formula 4.9 arises when considering the physical types of predictor materials. Certain suppliers, such as those who sell (e.g.) plumbing and heating materials will have no 'hands-on' experience of the number of bricks, or sand and gravel that customers may be purchasing. Thus, their ability to 'estimate' quarterly sales of such is implausible. Subsequently, the need for materials suppliers to work together and share information on the demand and price fluctuations of the materials they sell is necessary if Formula 4.9 is to be used with any accuracy.

It is reiterated at this point that this section of the research reports one component only of a conceptual model for evaluation of contractors' creditworthiness. Future aspects of the research that need investigation are whether 'estimated' data figures for the independent variables in the regression model would provide sufficiently accurate identifiers of credit risk (insinuated through contractor insolvency), or if it is advantageous to wait and use actual published data; even though there is a time lag associated with the latter. It maybe the case that both 'estimated' and published figures should be used in the final creditworthiness evaluation model; only future research could answer this question.

4.4.5.2 Regression model noise

Formula 4.9 detailed that any model used for forecasting future events will inevitably have an element of error. When predicting contractor insolvency, there are a plethora of influences that need consideration, in tandem with the regression model (Formula 4.9). Some of these factors being:

- Interest rates influence loan repayments. Since borrowing by construction clients is often required to finance construction work, the higher interest rates are, the lower is construction demand. Construction industry clients at times of high inflation realise the 'time value of money' (Pilcher, 1992) and are likely to delay payment (Haverstock, Unknown). Because materials suppliers are positioned low on the 'hierarchy' of the construction supply chain, fluctuations occurring higher up in the chain are likely to be magnified when payment eventually reaches the materials supplier. That is, if payment by the client is late to the contractor, the contractor then delays payment to sub-contractors so as to recoup interest losses from the initial late payment, and then the sub-contractor mirrors this late payment to the materials supplier. Because contractor insolvency is generally related to their cash flow status (Lowe, 1997a pp.87-88), delayed payment by an employer can induce cash flow problems for a contractor. If this situation continues for any length of time, then the potential for contractor insolvency is magnified. Because suppliers, who are unsecured creditors, have allowed the contractor credit, there may be a direct link between interest rates and suppliers' potential bad debt. Future research is evidently needed to confirm the (logical) assumptions between interest rates and contractor insolvency levels.

- The number and size of future contracts available for which resources can be employed will influence construction insolvencies. The clients' decision to build is a highly complex one requiring consideration of many factors. Further, since there is no 'typical customer', the notion that construction demand is predictable is somewhat unreliable.
- Government legislation alters demand for construction work. For example, it has become evident that attracting foreign companies to set up factories in this country is influenced by many factors, such as employment rates and UK attitude towards a common currency. These factories often employ large amounts of construction resources, and so again, directly impact construction demand.

The above mentioned factors of macroeconomic demand cannot reliably be built into a macro model when considering the resource constraints that contractor creditworthiness evaluation is enshrined with. However, the three bullet points do have an influence on the 'contractor insolvency prediction' problem being discussed. The three examples given are by no means an exhaustive list. Taking elements to consider to a decisive end would require considerable amounts of resources. However, what the list of points does achieve is to act as a basis upon which future lines of investigation could follow and, serve to put the output of the model (contractor insolvency prediction) into a broader context.

Having presented the caveats associated with using the regression model (Formula 4.9) it is worth considering whether there is any real need to use the contractor insolvency regression model in its 'proper' mathematical context. For instance, as has been previously mentioned, the price equilibrium mechanism will induce suppliers to make changes to the price they sell materials at, so that they can remain competitive. As this is the case, if suppliers incorporated an element of their working knowledge of prices that contractors are willing and able to pay for materials, then it is possible for suppliers to gain a knowledge of the business environment prosperity. From this knowledge suppliers should be able to gain an indication of contractor insolvency levels and hence the risk that their organisation is exposed to by furnishing contractors with credit. Inevitably, by removing a statistical procedure and replacing it with suppliers' personal judgement induces questions relating to suppliers' judgement of evaluating the present business environment and then relating this to contractor insolvency. However, since contractor creditworthiness evaluation is constrained in both time and finance resources available (Chapter 7), consideration has to be given to less costly analyses such as using suppliers' judgement for evaluation of future insolvency levels based on prices materials are being sold at. Yet again, only future research can answer the question of whether suppliers' judgement is of sufficient accuracy in forecasting contractor insolvency levels and the respective credit risk that fluctuations in insolvency imposes on suppliers' credit risk.

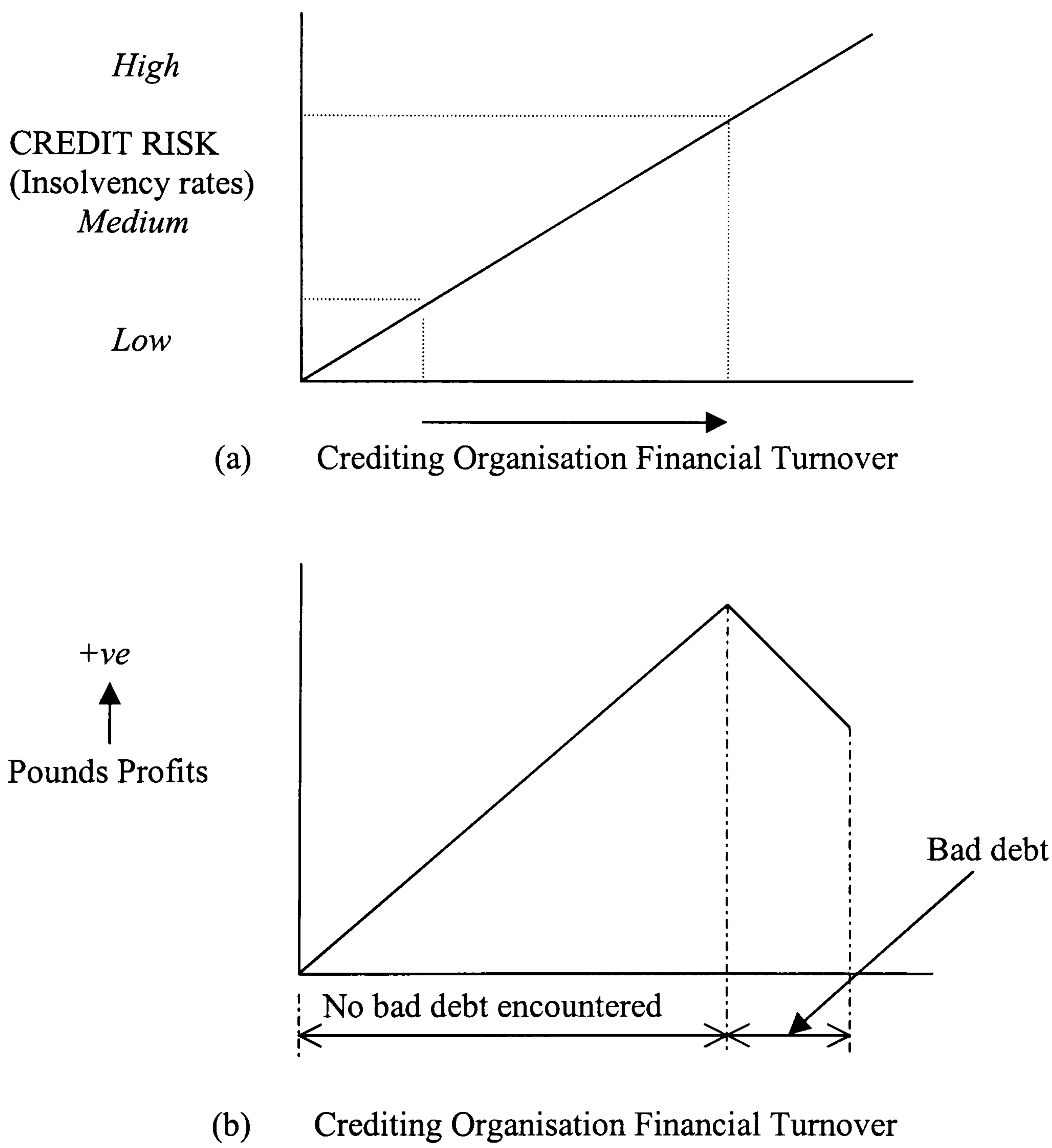
4.4.6 Insolvency and credit risk

So far in this chapter, total numbers of construction contractor insolvencies have been considered in relative isolation to the main aim of this thesis. That is, there is a need to link the prediction, and occurrence of contractor insolvency, to the risk that materials suppliers expose themselves to when they furnish financial credit. It has to be borne in mind that by allowing a contractor to (lawfully) remove materials from a supplier's stores and install them on site before payment is made (by the contractor) for such material, induces considerable risk onto the supplier. Therefore, to relate forecasts of contractor insolvencies to the risk that suppliers expose themselves to when allowing contractors credit needs consideration. This chapter now considers this (insolvency prediction verses supplier financial risk exposure) relationship.

Having 'related' contractor insolvency to supplier credit risk, it is possible to construct a conceptual risk diagram that contrasts contractor insolvency with supplier risk (see Figure 4.10). From this diagram, it is possible to derive that there must be an optimum level of financial risk that a crediting organisation (supplier) should expose themselves to, to maximise its potential client base (Figure 4.10). It is assumed here that maximising client base is inimical with profit maximisation (Black and Bradley, 1980).

It will be noted that the X-axis in Figure 4.10 is labelled 'crediting organisation financial turnover'. This 'label' has been used as it has been found that those suppliers with a 'large' financial turnover experience less loss in utility when a contractor defaults upon payment, than compared to suppliers with less 'sizeable' financial turnover (Chapter 5). Evidently, by using the regression model presented in this chapter it is possible to observe trends in insolvency patterns. When relating these insolvency patterns to Figure 4.10, suppliers should be able to gain insight into the financial risk that they expose themselves to by allowing contractors credit. The derived risk diagram fails to incorporate any figures relating to contractor insolvency numbers; it arbitrarily discriminates between ‘low’, ‘medium’ and ‘high’ numbers of insolvencies. Hence, future work is evidently needed to define ‘real’ numbers in this respect.

Figure 4.10
Crediting organisations’ risk related to contractor insolvency levels



At present, it is hypothesised that different suppliers, in terms of their characteristics, will perceive different numbers of contractor insolvencies as imposing subjectively different quantities of risk upon them. This will be a function of supplier size (capital structure), market share, geographical spread and other such characteristics. Therefore, it is necessary for each individual supplier to quantify these subjective aspects for themselves. That is, in these respects it is difficult and dangerous to generalise.

Since observations made relating to variable '*E*' of the conceptual model (Formula 3.3.) in the latter section of this chapter relate to the risk that suppliers are prepared to accept in return for gaining a contractor's trade, there is commonality between observations made here and the decision making section. Because of this evident 'utility' theme emerging from this research, Chapter 5 specifically concentrates upon utility and its application to the risk that suppliers expose themselves to when they furnish contractors with credit.

4.5 SUMMARY AND REVIEW OF RESEARCH FINDINGS

An infinite number of business relationships exist between contractors and their suppliers. Relationships have to be based upon trust; the greater the trust the more chance of a strategic partnership evolving. With the need by construction contractors to reduce their costs (Latham, 1994; Egan, 1998) there is scope for greater collaboration between contractors and materials suppliers. When considering creditworthiness implications and trust between suppliers and contractors, then the more mature a relationship between organisations, the greater the amount of trust between them. One possible conclusion is that short-term business relationships are more risky than longer term ones.

It has also been identified that prediction of contractor insolvency is a complex interaction of many factors. By analysing macroeconomic factors closely related to suppliers' working environments, a fundamental regression model has been developed for predicting contractor insolvency rates. By further incorporating a concurrent form of subjective decision making process to the model output, it is possible to identify the amount of risk that suppliers are prepared to expose themselves to.

The regression model identified that contractor insolvency levels are highly related to: construction materials price indices for housing; the quantity of bricks sold; and the volume of sand and gravel deliveries made in one quarter of a year. By performing mathematical transformations on these factors, an insight into present and future contractor insolvency levels are gained and hence, possible fluctuations in risk associated with interacting with 'financially unstable' companies determined.

It is accepted that the sub-models in this chapter to some extent generalise the issue at hand, but it is a foundation in an area for which very little previous work exists. In this respect the sub-models in this chapter are entirely novel.

In terms of the overall research contained in this thesis, this chapter has reinforced the assertions made in Chapter 3 regarding present creditworthiness evaluation procedures failing to consider a number of potential influences of whether contractors will honour their debts, or not. Indeed, this chapter has raised as many questions as it answers. Thereby proving two distinct conclusions:

i. there is a lack of research into the evaluation of potential debtors' (contractors') creditworthiness; and
ii. that the observations made throughout this thesis to date, do contribute to the knowledge domain.

Because regular and periodical reviews of this research's findings were compiled and reported to the academic community (see Nicholas, et al., 1998; 1999; 2000b; 2000d; and 2000f and as outlined in sections 1.2 and 1.3 of chapter 1: aims and objectives of the research and research methodology respectively), it became evident that the research was uncovering too many avenues of further research for this one PhD thesis to consider. This meant that a strategic decision had to be made regarding future research activities to be undertaken in this PhD programme. Hence, a decision was made to concentrate upon the utility experienced by a supplier when they grant a contractor credit. The basis for this decision was:

i. suppliers are so important to the construction industry, in terms of the amount of working capital they furnish it with, that research into this source of finance is important;
ii. following on from i. that suppliers need to perceive themselves as 'gaining' from exposing themselves to the risk of incurring bad debt;

iii. that detailed consideration of elements E and M **both** identified that suppliers' perception of potential interaction had to be considered in any creditworthiness evaluation model; and

iv. a paper had been written and a conference presentation made (Nicholas and Holt, 1999; and Nicholas, et al., 2000e) which had detailed the influence, in terms of utility experienced by a supplier, when they furnish a contractor with financial credit. The comments received from *Construction, Management and Engineering's* referees and the RICS COBRA conference (1999) attendees indicated to the author greater consideration into the utility aspects of furnishing credit was required.

Based on these points, a decision was made to concentrate future research on modelling factors, identified as influencing the utility that a supplier experiences from granting a contractor financial credit.

In summary, having in detail considered elements E and M of Formula 3.3 (conceptual model for evaluating contractors' creditworthiness) in this chapter, the next chapter considers the influences upon suppliers' utility from granting financial credit to contractors.

CHAPTER 5

INFLUENCES ON SUPPLIERS' UTILITY WHEN FURNISHING CONTRACTORS WITH CREDIT

5.1 INTRODUCTION

This chapter specifically concentrates on contractor financial credit limits, their derivation, and subsequent implications on materials suppliers' utility (from trading with contractors). The need for concentrating on this particular aspect of suppliers' credit risk are threefold. That is:

i. It has been highlighted by the literature review (Chapter 2) and results of surveying suppliers' credit control and debt collection procedures (detailed in Chapter 7 later) that, contractor creditworthiness procedures and subsequent credit limit methodologies **all** fail to consider the characteristics of the creditor and debtor simultaneously.

ii. Because the definition of 'creditworthiness' (Chapter 3) being used in this research demands that supplier and contractor characteristics are considered in tandem.

iii. The conceptual creditworthiness evaluation model (e.g. section 3.6 in Chapter 3) requires consideration of the amount of credit allowed by a supplier, to be taken into account (i.e. generic items D and Cr).

iv. A number of variables included in the conceptual model (Formula 3.3) use subjective measurements (e.g. potential debtors' decision-making traits; strategic decision making characteristics of supplier and contractor etc.). Because of the qualitative nature of this data (that nonetheless need to be 'measured' for accurate contractor creditworthiness evaluation), utility measurements are an ideal method of converting subjective data into quantitative measures. This quantitative measurement is then easier to interpret and gauge decisions against.

It is important to consider the influence upon a supplier, that the quantity of credit furnished to a contractor (i.e. contractor credit limit) has. This is because the greater the amount of credit furnished, the greater the amount of credit risk exposure to the supplier. This chapter looks at influences and background issues that impact upon suppliers' credit risk for a potential debtor (contractor). The chapter simultaneously discusses and critically appraises current methodologies for 'calculating' contractors' credit limits. Following on from this, a new approach is presented to identify whether the risk associated with granting an additional contractor with credit, results in a worthwhile gain in utility for the creditor, or not.

5.2 CREDIT LIMIT BACKGROUND ISSUES

It is generally accepted that the credit facilities furnished by materials suppliers to construction contractors, forms an intrinsic element of working capital for those 'borrowing' organisations (Lowe, 1997b; Agapiou, et al., 1998). The greater the amount of 'free' credit that can be obtained by a contractor from suppliers, directly relates to a contractor's potential profitability and subsequent enhanced probability of survival. 'Free' credit in this sense is defined as that quantity of finance obtained from suppliers that is not directly 'charged' to debtors (e.g. for the use of such a service or in interest charges).

Evidence relating to the methods that suppliers use to determine credit limits emanated from a UK nation-wide structured survey of materials suppliers' credit control and debt collection procedures (described in detail, later in Chapters 6 and 7). The survey identified what evaluation methodologies are used and what outside organisations are approached by suppliers in order to gain details of contractors' creditworthiness. From investigating these issues, it was found that suppliers presently have little accurate knowledge of the risks that they are exposing themselves to, when they furnish credit. A succinct but critical appraisal of present credit limit methodologies now follows.

5.3 CREDIT LIMIT METHODOLOGIES IDENTIFIED

Three principal methods used by suppliers for establishing credit limits were identified from the survey, these being:

i. Time duration of business relationship between supplier and contractor.
ii. Credit registers.
iii. Bank references.

These three methods of credit limit derivation are now individually detailed.

5.3.1 Time duration of supplier / contractor business relationship

Previous research has identified that the longer (time duration) a business relationship between organisations continues; the greater the mutual knowledge (and dependency) of each other becomes (Sako, 1992; Grant and Schlesinger, 1995; Jarillo, 1995). Logically therefore, the longer the business relationship between supplier and contractor, then the more accurate should be the decision regarding the quantity of finances a contractor should be allowed to borrow from a supplier. From this time dependent interaction, suppliers insinuate that they can gather sufficient information on a contractor (potential debtor) to define a maximum level of permissible credit.

There are numerous caveats associated with this approach. First, how can an initial credit sum be calculated if no prior business relationship exists between the two interacting organisations? Second, how dynamic is the crediting organisation's decision making, regarding (e.g.) a contractor's workload and associated impact(s) of their market place? (these impact ability to repay debts). For instance, if a contractor concentrates resources on one major construction project, then the implications for overall cash flow may result in cash starvation elsewhere.

5.3.2 Credit registers

Credit registers' methods of defining contractors' credit limits exhibited a common underlying philosophy that credit limits be determined predominantly on a contractor's previous years' financial accounts. For confidentiality, Credit register names and exact methods of determining credit limits are not made explicit here. However, it was noted from the final recommended financial credit limit that different credit registers defined different credit limits for the same potential debtor. For example, when one set of contractor's accounts were considered, then application of one particular Credit register methodology resulted in an additional 25 per cent of credit being recommended (above the arithmetic mean credit limit defined by all other Credit register methodologies considered). Therefore, there seems no definitive answer at this time (based on observations of Credit registers) to the question: *"What should the credit limit of a potential debtor be?"*

In contrast, some Credit registers derived credit limits for *'guidance only'* and stated that the calculated sum (credit limit) should only be used as a *'ceiling'*. This would indicate that organisations that compile Credit registers question their reliability, reproducibility and robustness. Some Credit register methodologies took into consideration a contractor's repayment history and any previous County Court Judgements served against them. However, the majority of Credit registers would not recommend that a potential debtor was unworthy of credit facilities!

5.3.3 Bank references

Information supplied by Banking corporations generally pointed to credit limits being derived from five areas of investigation:

i. Ability of a potential debtor's management to understand and control the financial aspects of their business.

ii. Previous years' profitability and general 'health' of a potential debtor's balance sheets, including projected organisation turnover (the time duration was not stated for this. However, one would assume that it is a function of the amount of credit being sought).

iii. Organisation liquidity i.e. what is the 'borrowing requirement' and expected rhythm of payback by the debtor?

iv. Available security for goods supplied.

v. Overall risk to the lending institute (considering the potential debtor's market place and other economic factors).

Here again, it is evident that the subject of lending finances is still something of an 'art form' rather than a 'science' (Rouse, 1991). However, the greater degree of investigative methodologies used by Banks (in comparison to Credit registers) does highlight the flaws of purely accountancy-based techniques, in attempting to accurately define the risk that debtors can impose onto creditors.

None of the credit limit methodologies identified from the survey, considered the financial characteristics of the lending institute. Therefore, regardless of whether the supplier's turnover was £1m or £25m per year, the (potential) imposed credit risk of furnishing a given contractor credit was generally implied as identical! In an ideal situation, the final decision to grant credit, or not, should not only depend upon the perceived risk (to the supplier), but also a number of external factors (as detailed in Chapter 3). This way an accurate knowledge can be gained as to whether the financial risk of granting credit is too great for the organisation, or otherwise.

Obviously, because of the caveats identified with present credit limit methodologies, there is a need for closer scrutiny of a potential debtor's credit limit evaluation.

Currently, no consideration is given to a supplier's asset base, which would if necessary, be used to counteract bad debts. Gearing calculations might identify a potential risk level in this respect (gearing is defined as current plus fixed liabilities over the net worth of the debtor; net worth being, total assets minus total liabilities [Coleshaw, 1989]). However, as with all other accounting ratios, gearing fails to be explicit in quantifying risk exposure. In that all present credit limit methodologies appear to have inherent flaws (albeit to varying extents), this chapter presents a new approach to quantifying imposed contractor credit risk. The model proffered takes into account both creditor and debtor financial characteristics; something that to date, no other risk analysis system has done. The model evolves from consideration of *why* suppliers are in business, and *how* changes in supplier utility impact upon associated credit risk, and vice versa.

The chapter presents a totally new conceptual approach to the 'problem' of suppliers having to decide whether to furnish credit to contractors. It is shown that the nature and extent (quantity) of credit furnished, impacts directly on the level of financial risk that the creditor is exposed to. Description of the utility model shows that credit limits should in part be a function of:

- the accuracy of creditworthiness evaluation procedures used;
- the contractor's credit demands; and
- potential profitability of the trading 'relationship' to the supplier.

The data used in this chapter (i.e. upon which conclusions are drawn), emanate from both survey and theoretical analysis. All formulae presented are conceptual and empirical. The reason for introducing these new formulae are that present credit evaluation procedures fail to consider a number of key factors when analysing potential debtors' creditworthiness and thus, expose the creditor to a presently unknown level of risk. In this respect, these formulae 'lay a foundation' upon which future research could build.

5.4 CREDIT RISK ANALYSIS

Economic theory of the firm dictates that business decisions essentially seek to maximise profits (Lipsey, 1989 p.170). Falling profit results in decreased financial backing. Such demands (risk) mean that there is a balance to be maintained between the risk tolerable by an organisation and that risk which is imposed upon it. Unless a materials supplier operates a monopoly, a balance must be met between desired profit margins and competition imposed by other suppliers. This relationship may be formalised via:

$$\textit{Supplier profit maximisation} = f\,(\textit{optimal decision making considering internal and external factors impacting upon organisational survival}) \quad \text{(Formula 5.1)}$$

The nexus of the concept behind Formula 5.1 is this: supplier profit maximisation is in part, a function of imposed risk when furnishing credit to contractors. If such a risk *'ceiling'* could be accurately defined, it follows that enhanced decisions regarding contractors' credit limits could be made. That is, present inaccurate methods of credit analysis and subsequent risk exposure to crediting organisations could be improved upon in the light of this one aspect alone. To achieve this improvement it is necessary for a supplier to consider if the potential gain (i.e. utility gain) from granting credit to an additional contractor (i.e. the additional risk) is worthwhile.

5.4.1 Suppliers' utility measures

Different classifications of materials suppliers are possible. For example, in terms of products supplied or financial characteristics (turnover, profit margin targets, debt collection procedures etc.) (Chapter 7). The effect of this when considering credit limits, is that some suppliers will consider the risk of one contractor's business as a worthwhile 'gamble', whilst another may perceive the opposite. That is, the utility from potential trading gains has to be balanced with the effort and resources expended on achieving this increase.

Lipsey (1989 p.149) reinforced this contention and detailed three kinds of risk taker: *risk averse, risk lovers* and *risk neutral. Risk averse* will only interact in a transaction if the probability of them gaining from the outcome is sufficiently biased in their favour. *Risk lovers* will interact in a transaction regardless of how high the stakes are against them breaking even. Between these two extremes lie *risk neutral*; here interaction is undertaken if the probability of them winning is even, or greater. Therefore, the marginal potential utility from an additional contractor's trade, gained from furnishing credit, must appear sufficiently attractive for *risk averse* and *risk neutral* suppliers to enter into such a business relationship.

It may be argued that *risk averse* and *risk neutral* organisations would not survive in the competitive market of materials supply. However, if organisations with these characteristics have a 'better' ability to foresee and avoid potential bad debt, then they will have a better probability of survival. Ultimately, with risk should come reward; this chapter aims to quantify imposed credit risk, against which decisions could be made to grant credit or not. This is something that no other research has ever attempted.

To manipulate the interaction between supplier and contractor with regard to quantifying credit risk, there are three prime factors requiring consideration. These being:

i. The potential quantity of profit to be gained from the interaction. The greater this is, the more likely the supplier will accept the risk.
ii. The quantity of finances to be borrowed. The greater this is, the greater the creditors' risk.
iii. The probability of the contractor defaulting upon repayment.

From (i) to (iii) it is evident that contractors' credit limits should impose an identical level of risk to a 'large' financial turnover supplier as it would a 'small' turnover supplier. Thus, 'small' suppliers should furnish a lesser amount of credit than 'large' suppliers for any given contractor. That is, the marginal utility of an additional contractor's trade should impact to an identical level for all suppliers between the extremes of 'small' and 'large'.

Because the majority of suppliers already furnish credit to a number of contractors, suppliers' present and initial level of utility, against which future evaluations may be made, can be conveniently designated as one hundred per cent. This level is then either enhanced or reduced depending upon whether an additional (new) contractor furnished with credit honours their debt, or not. The level to which a single contractor can influence a supplier's utility requires close scrutiny. This is because if it is possible to define the impact of one individual debtor then it is subsequently possible to determine the influence of a number of debtors who have similar characteristics, and require similar credit services from a supplier. If a supplier decides to grant an additional contractor credit, and that contractor honours their debts, the initial utility level of the supplier increases. Therefore, if a similar quantity of utility is to be gained from future trade, credit risk should increase in proportion to the supplier's financial characteristics (i.e. a compounding affect); making the evaluation of credit limits a dynamic phenomenon.

If utility theory is considered in relation to the quantity of credit furnished it is necessary to question whether, on commitment, the additional credit risk is 'worth' it. That is, in response to this extra degree of risk exposure, is there sufficient potential return to achieve a net utility gain?

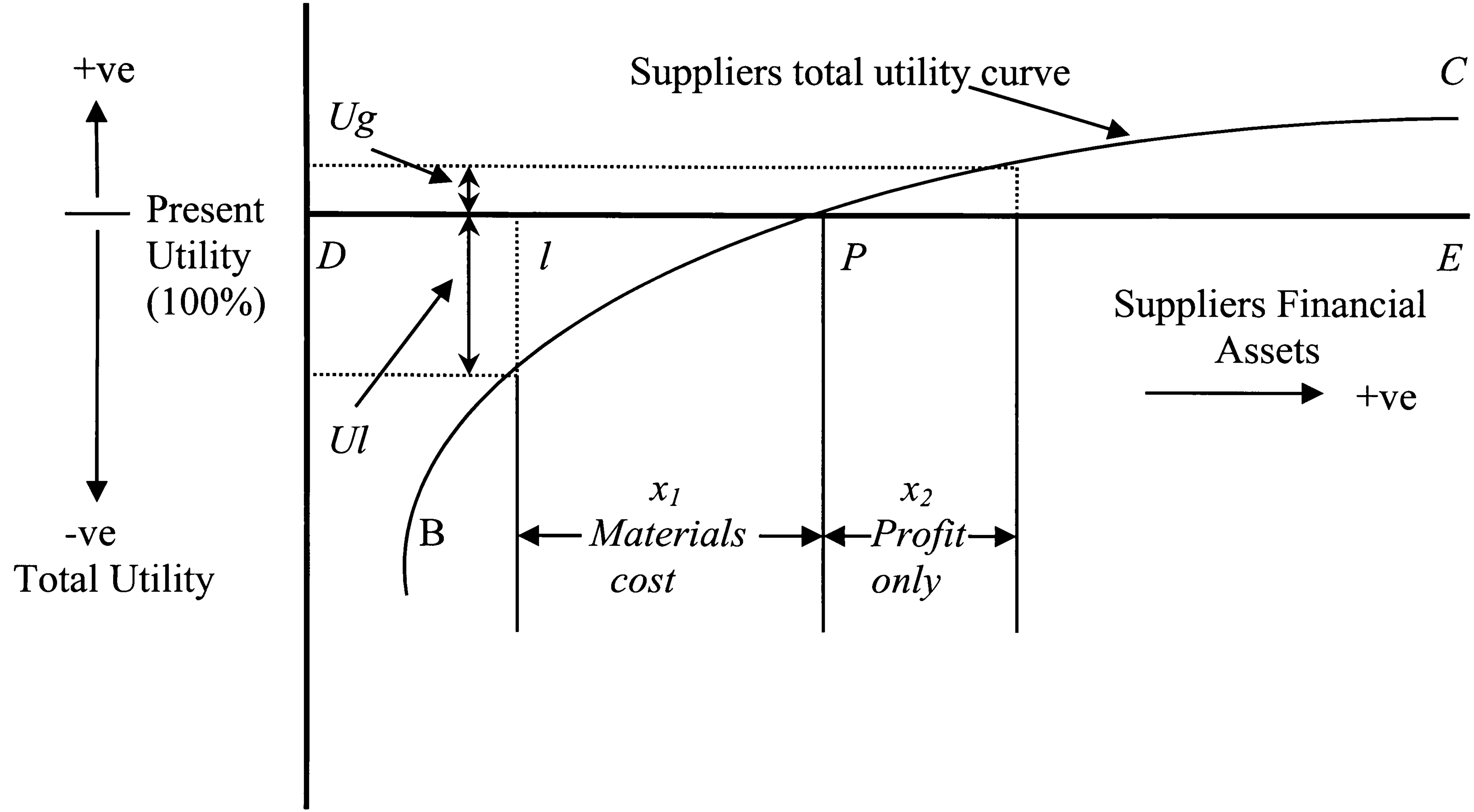
5.4.2 Utility derivation

Utility is a highly individualistic characteristic. Since individual's tastes, circumstances and consumption patterns change, their implications upon utility is something of an un-quantifiable concept (Sloman, 1994 p.126). To define a precise formula for calculating the potential utility of allowing a contractor credit, would be impossible; different suppliers' utility curves would exhibit different properties. However, if one applies Bernoulli's (1738) risk theory, a generalisation regarding possible benefit from an additional contractor's trade can be made.

With reference to Figure 5.1, it can be stated that the incremental impact on the hypothetical utility line *BPC* is linear when the utility from an additional contractor's trade is considered. This generalisation is made on the premise that suppliers are profit lovers and hence want to maximise their quantity of profit made. Therefore, any future potential profit to be made must be perceived as equally important as that already gained from trading; regardless of the 'financial' size of the supplier. The market forces of other suppliers constraining profit margins via competition, generally means that the only way profit maximisation or expansion can be achieved is through maximising market share. Considering the utility curve in Figure 5.1, and taking the previous maxim, it can be stated that for profit maximisation purposes the trade of one additional contractor is proportional to that gained from previous contractors' trade. As soon as the utility curve shows greater horizontal characteristics than vertical, the notion of profit maximisation is lost.

Individual suppliers' utility curves could be derived. Alternatively, a 'general' supplier utility curve could be determined via survey. However, this is beyond the remit of this thesis; which concentrates on determining utility values from one additional contractor's trade. The model presented in this chapter provides an indication of the change in overall supplier utility when furnishing an additional contractor with credit. If the utility from an additional contractor's trade results in 'large' gains, one may question if the supplier has considered the high level of

Figure 5.1 – Implications for Utility with Changing Financial Risk



financial risk (potential debt) that (in this instance) they are exposed to; should that one contractor default on repayment. The question, 'is the supplier allowing one contractor too great an influence upon their organisation?' springs to mind. Utility is a personal 'feeling', so the definition of maximum utility gain from a single contractor is ultimately a decision for the supplier.

Having outlined the conditions upon which utility calculations could be based, the use of Bernoulli's (1738) philosophical theory for measuring risk can now be considered. It was stated that:

> *'Any gain must be added to the fortune previously possessed, then this sum must be raised to the power given by the number of possible ways in which the gain may be obtained; these terms should then be multiplied together. Then of this product a root must be extracted the degree of which is given by the number of all possible cases, and finally the value of the initial possessions must be extracted therefrom; what then remains is the value of the risky proposition'* (ibid.)

So far this statement has only considered one side of the equation i.e. the contractor either honouring their debts or not. Subsequently, when considering both elements of the 'gamble' associated with granting a contractor credit, Formula 5.2 evolves viz.:

$$\sqrt[Poa]{(F+x)^{Ps}.(F-Mc)^{Pf}} \geq F \qquad \text{(Formula 5.2)}$$

Where: Poa = total probability i.e. one hundred per cent; F = existing potential profitability; x = profit to be made from contractor's trade in question; Ps = probability of success i.e. contractor honouring due debt; Mc = materials cost to supplier and; Pf = probability of failure i.e. contractor defaulting on repayment. In that the contractor either has to honour their debts or not then $Ps + Pf = Poa$.

Formula 5.2 is derived via considering game theory. Bernoulli (1738) suggested that when a game is played by two opposing people / organisations with identical financial characteristics, and they both gamble half of their resources on a win / loose situation (i.e. one organisation wins at the expense of the other), then the expected gain in utility to either organisation is less than the benefits gained from the gamble. Because of this self evident truth, it is suggested (ibid.) that:

i. Fair games are irrational: both parties lose in terms of utility gain.
ii. There is a need to consider the utility benefits that are achieved (if any) from the gamble and compare these against the risk involved. Factors influencing the perceived utility change will be:
    - the probability of winning and conversely losing; and
    - the finances that are exposed to risk in comparison to those that were initially possessed.

Having now outlined the theoretical derivation of Bernoulli's theory, consideration of Figure 5.1 allows graphical portrayal of the supplier / contractor interaction. Figure 5.1 identifies the present utility gained from a contractor's trade by the materials supplier (P) in relation to the financial asset structure of the supplier (DE).

If an additional contractor is offered credit facilities and they honour the agreement, an increase in the supplier's level of profit ensues (x_2) accompanied with a gain in utility (*Ug*). Conversely, if the (new) contractor defaults on payment, a loss occurs representing the cost of the materials to the supplier (x_1), this also being accompanied by a loss in utility (*Ul*). With the knowledge that the cost of materials to the supplier is normally more than the quantity of intended profit to be, it is evident that the utility loss from an unsuccessful transaction (contractor not paying debt) is significantly more than the potential utility gain should the contractor pay on time.

A further complication occurs when consideration is given to ownership of the materials sold on credit. It is common practice for suppliers' to incorporate a 'retention of title' clause into their terms of trading when offering contractors credit facilities. Depending upon the contractual relationship between supplier and client, there may be opportunity for the supplier to regain ownership of the materials (should the contractor fail to honour their debt), albeit at cost to the supplier (see further Murdoch and Hughes, 1996 pp.297-8). In this way, the only additional costs the supplier incurs are those associated with 'collecting' the materials; though hopefully actions like these are minimised or eliminated by suppliers' continually monitoring potential debtors creditworthiness. This scenario can be formalised via Formula 5.3 viz.:

$$\text{Residual value of materials regained} = \text{Initial materials cost} - \text{Depreciation} - \text{Other costs (e.g. delivery / collection / resale etc.)} \qquad \text{(Formula 5.3)}$$

Figure 5.1 highlights that utility changes are related to a supplier's potential for profit on a transaction, which may be used to counteract bad debt, (i.e. financial loss). Utility changes are also a function of the utility curve shape, but as stated earlier, a 'general' curve is hypothesised here, for concept demonstration purposes. The amount of profit to be made from a creditor / debtor transaction, directly relates to whether suppliers would envisage potential utility gains to be sufficiently large enough in relation to the cost of the materials for that given transaction (financial risk). Ultimately, for the same contractor's trade, 'large' (high annual turnover) suppliers will envisage the interaction less 'risky' than would a 'small' (less annual turnover) supplier. This is based on the assumption that the utility of one pound profit for a 'small' supplier, represents a significantly greater 'value' than it does for 'large' suppliers.

Having derived the formula for defining the influence in utility achieved by a supplier when furnishing a contractor with credit, and explanation of the formula's application in a utility curve setting, three sets of hypothetical financial figures (supplier characteristics and desired credit required by a contractor) are now considered. To portray the use of Formula 5.2 with 'real life' statistics, salient findings in respect of a national survey of materials suppliers' credit control and debt collection departments (Chapter 7) can be summarised as follows. For suppliers with turnover between £½m and £1m per year the following characteristics were observed:

- Bad debt, on average, accounted for between one and two per cent of suppliers' turnover.

- Average targeted profit margin (before bad debt is taken into account) is 15 per cent on turnover before tax.
- Three quarters of suppliers' turnover was accounted for by credit accounts.
- Suppliers each furnish an average of 141 contractors with credit (actual mean figure 140.63).
- Suppliers allowed credit of between £2,667 and £5,333 per year, per contractor, within the £½m to £1m turnover class.
- Credit limit imposition was based on three principal evaluation procedures: Bank supplied information, credit registers and the duration of business relationship between supplier and contractor.
- Over three-quarters of suppliers would not, or only sometimes, seek guarantees of payment if a contractor placed a substantial order.

Each scenario now presented represents an incremental change in three factors:

i. the probability of a contractor defaulting upon repayment;

ii. changing quantities of credit demanded and;

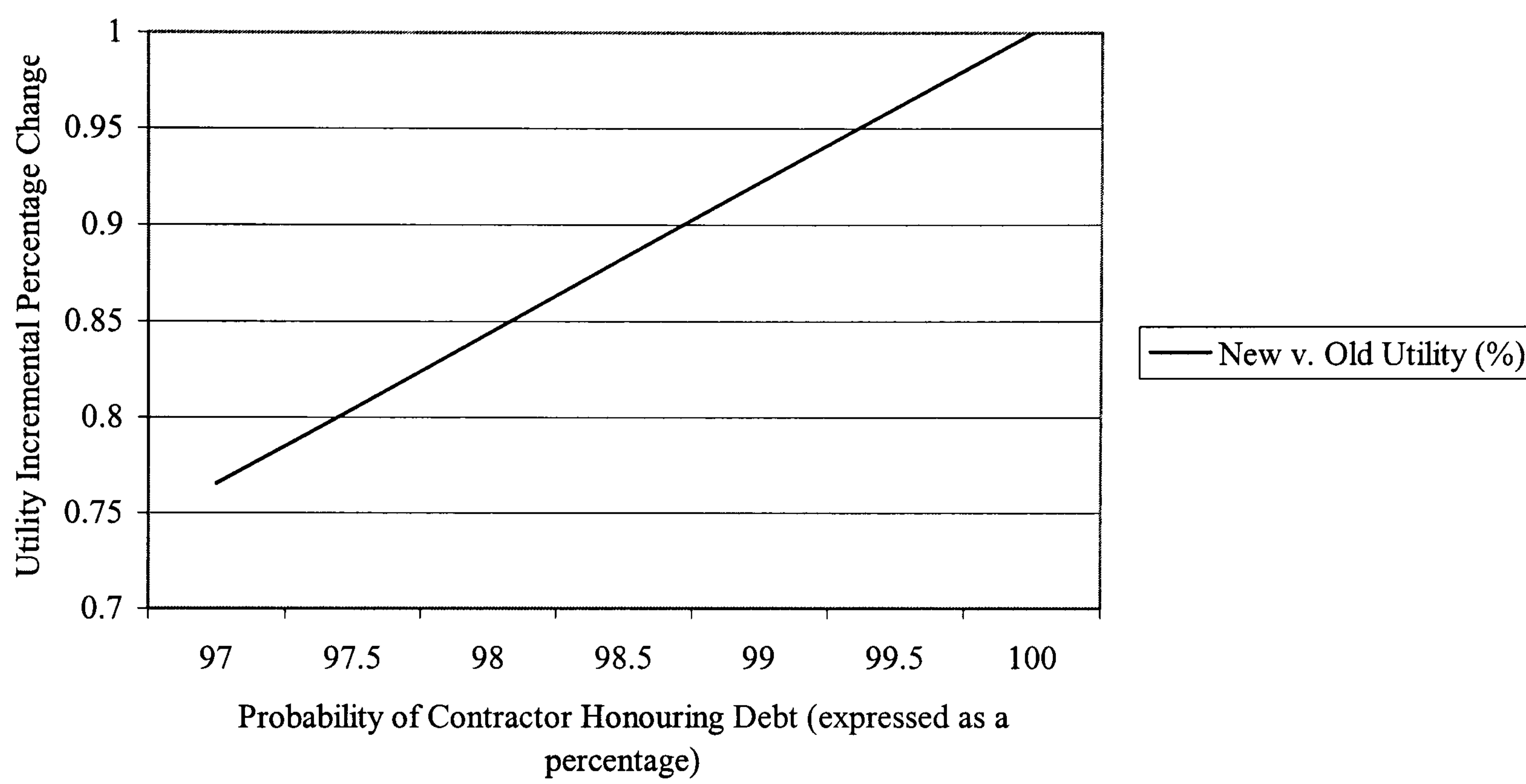
iii. changing targeted profit margins.

To make like-for-like comparison, the turnover of the materials supplier remains constant. A discussion then follows regarding the findings of these analyses.

5.4.3 Scenario one

A materials supplier has a turnover of £1m per annum and a targeted profit margin of 15 per cent on turnover. A contractor is seeking £5,333 worth of credit. If the probability of incurring bad debt ranges from zero to three per cent of the supplier's turnover (based on survey findings detailed in Chapter 7) the utility to be gained from the additional contractor's trade is identified by Graph 5.1; the mathematics underpinning graph one are shown in Table 5.1.

Graph 5.1 - New versus Old Utility (%) Changing Probability of Bad Debt



Thus, if there is a two per cent probability of incurring bad debt, based on the above data the following figures are inserted into Formula 5.4:

$$\sqrt[100]{(130{,}434.80+695.61)^{98}x(130{,}434.80-4637.39)^{2}} = £131{,}021.55 \quad \text{(Formula 5.4)}$$

Table 5.1
Scenario One: Supplier Turnover and Credit Required Remains Constant; Probability of Contractor Defaulting Upon Repayment Changes.

(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(J)	(K)	(L)	(M)
Observation Number	Suppliers Turnover	Cost of materials to supplier	Supplier's present profits (15 %)	Contractor's Credit Requirements	Cost of materials to supplier for contractor under consideration	Targeted profit to be made from additional trade	Probability of contractor honouring debts (expressed as percentage)	Probability of Contractor not honouring debts (expressed as percentage)	Utility value of additional trade plus original turnover	Utility value of new contractor's trade	Utility profits / Actual Profits
1	1,000,000.00	869,565.22	130,434.78	5,333.00	4,637.39	695.61	97.0	3.0	130,967.16	532.38	0.765
2	1,000,000.00	869,565.22	130,434.78	5,333.00	4,637.39	695.61	97.5	2.5	130,994.35	559.57	0.804
3	1,000,000.00	869,565.22	130,434.78	5,333.00	4,637.39	695.61	98.0	2.0	131,021.55	586.76	0.844
4	1,000,000.00	869,565.22	130,434.78	5,333.00	4,637.39	695.61	98.5	1.5	131,048.75	613.97	0.883
5	1,000,000.00	869,565.22	130,434.78	5,333.00	4,637.39	695.61	99.0	1.0	131,075.96	641.18	0.922
6	1,000,000.00	869,565.22	130,434.78	5,333.00	4,637.39	695.61	99.5	0.5	131,103.17	668.39	0.961
7	1,000,000.00	869,565.22	130,434.78	5,333.00	4,637.39	695.61	100.0	0.0	131,130.39	695.61	1.000

NOTES

- Data in columns H and J obtained from survey data (see Chapter 7).
- Column C = £1,000,000 / 1.15 = £869,565.22.
- Column D = column B – column C.
- Column F = column E / 1.15 = £4,637.39.
- Column G = column E – column F.
- Column K uses formula 5.2 to identify the 'new' utility of the additional contractor's trade.
- Column L = column K – column D.
- Column M = column L / column G.

Hence, the 'utility factored value' of profit made from this additional interaction is £131,021.55 - £130,434.80 = £586.75. This figure represents 84.4 per cent (£586.76 / £695.61) of the 'physical' value of profit.

Graph 5.1 shows that the greater the probability of the supplier incurring bad debt, the less utility gain the supplier can expect. That is, the actual profit from the 'new' contractor fails to equal the value of the potential maximum profit from this interaction when using Bernoulli's formula. If the data in this example are taken to extremes, it becomes evident that if the probability of a contractor defaulting upon repayment falls below 87.2 per cent, then potential utility is at equilibrium with the risk of furnishing the contractor credit. That is, a lower 'utility threshold' is determined (in this example) at 87.2 per cent or 0.87 probability of contractor re-payment.

5.4.4 Scenario two

This is as per scenario one, but the quantity of credit furnished the contractor increases in increments of £5,333 and the probability of bad debt remains constant at 1.5 per cent of the supplier's turnover.

When inserting this data into Formula 5.2, the figures in Table 5.2 are obtained. Graph 5.2 shows that as the quantity of credit allowed increases, there is a respective reduction in potential utility experienced by the supplier. Furthermore, the utility

Table 5.2
Scenario Two: Suppliers Turnover and Probability of Bad Debt Remains Constant but Contractor Credit Demands Change

(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)
Observation Number	Suppliers Turnover	Cost of materials to supplier	Supplier's present profits (15 %)	Contractor's Credit Requirements – increases in £5,333 increments	Cost of materials to supplier for contractor under consideration	Targeted profit to be made from additional trade (15 %)	Probability of contractor honouring debts (expressed as percentage)	Probability of Contractor not honouring debts (expressed as percentage)	Utility value of additional trade plus original turnover	Utility value of new contractor's trade	Utility profits / Actual Profits
1	1,000,000.00	869,565.22	130,434.78	5,333.00	4,637.39	695.61	98.5	1.5	131,048.75	613.97	0.883
2	1,000,000.00	869,565.22	130,434.78	10,666.00	9,274.78	1,391.22	98.5	1.5	131,659.27	1,224.49	0.880
3	1,000,000.00	869,565.22	130,434.78	15,999.00	13,912.17	2,086.83	98.5	1.5	132,266.10	1,831.32	0.878
4	1,000,000.00	869,565.22	130,434.78	21,332.00	18,549.57	2,782.43	98.5	1.5	132,868.96	2,434.18	0.875
5	1,000,000.00	869,565.22	130,434.78	26,665.00	23,186.96	3,478.04	98.5	1.5	133,467.54	3,032.76	0.872
6	1,000,000.00	869,565.22	130,434.78	31,998.00	27,824.35	4,173.65	98.5	1.5	134,061.50	3,626.71	0.869
7	1,000,000.00	869,565.22	130,434.78	37,331.00	32,461.74	4,869.26	98.5	1.5	134,650.42	4,215.64	0.866
8	1,000,000.00	869,565.22	130,434.78	42,664.00	37,099.13	5,564.87	98.5	1.5	135,233.86	4,799.08	0.862
9	1,000,000.00	869,565.22	130,434.78	47,997.00	41,736.52	6,260.48	98.5	1.5	135,811.29	5,376.51	0.859
10	1,000,000.00	869,565.22	130,434.78	53,330.00	46,373.91	6,956.09	98.5	1.5	136,382.11	5,947.33	0.855
11	1,000,000.00	869,565.22	130,434.78	58,663.00	51,011.30	7,651.70	98.5	1.5	136,945.61	6,510.83	0.851
12	1,000,000.00	869,565.22	130,434.78	63,996.00	55,648.70	8,347.30	98.5	1.5	137,500.96	7,066.18	0.847
13	1,000,000.00	869,565.22	130,434.78	69,329.00	60,286.09	9,042.91	98.5	1.5	138,047.16	7,612.38	0.842
14	1,000,000.00	869,565.22	130,434.78	74,662.00	64,923.48	9,738.52	98.5	1.5	138,583.04	8,148.25	0.837
15	1,000,000.00	869,565.22	130,434.78	79,995.00	69,560.87	10,434.13	98.5	1.5	139,107.13	8,672.35	0.831
16	1,000,000.00	869,565.22	130,434.78	85,328.00	74,198.26	11,129.74	98.5	1.5	139,617.67	9,182.89	0.825
17	1,000,000.00	869,565.22	130,434.78	90,661.00	78,835.65	11,825.35	98.5	1.5	140,112.41	9,677.62	0.818
18	1,000,000.00	869,565.22	130,434.78	95,994.00	83,473.04	12,520.96	98.5	1.5	140,588.48	10,153.70	0.811
19	1,000,000.00	869,565.22	130,434.78	101,327.00	88,110.43	13,216.57	98.5	1.5	141,042.15	10,607.37	0.803
20	1,000,000.00	869,565.22	130,434.78	106,660.00	92,747.83	13,912.17	98.5	1.5	141,468.38	11,033.60	0.793
21	1,000,000.00	869,565.22	130,434.78	111,993.00	97,385.22	14,607.78	98.5	1.5	141,860.19	11,425.40	0.782

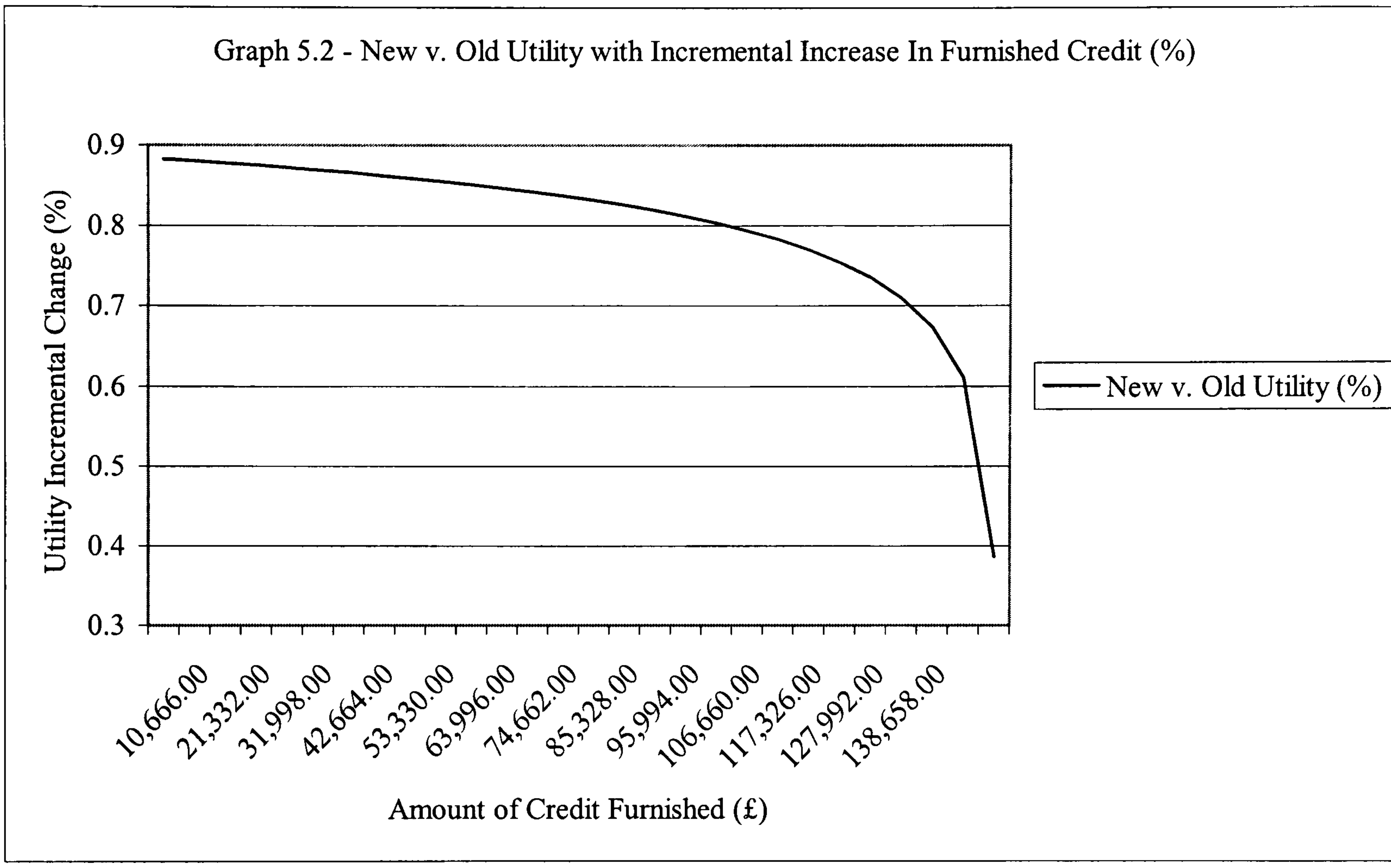
Table 5.2 continued

22	1,000,000.00	869,565.22	130,434.78	117,326.00	102,022.61	15,303.39	98.5	1.5	142,207.43	11,772.65	0.769
23	1,000,000.00	869,565.22	130,434.78	122,659.00	106,660.00	15,999.00	98.5	1.5	142,494.60	12,059.82	0.754
24	1,000,000.00	869,565.22	130,434.78	127,992.00	111,297.39	16,694.61	98.5	1.5	142,696.13	12,261.35	0.734
25	1,000,000.00	869,565.22	130,434.78	133,325.00	115,934.78	17,390.22	98.5	1.5	142,765.14	12,330.36	0.709
26	1,000,000.00	869,565.22	130,434.78	138,658.00	120,572.17	18,085.83	98.5	1.5	142,600.09	12,165.31	0.673
27	1,000,000.00	869,565.22	130,434.78	143,991.00	125,209.57	18,781.43	98.5	1.5	141,899.33	11,464.55	0.610
28	1,000,000.00	869,565.22	130,434.78	149,324.00	129,846.96	19,477.04	98.5	1.5	137,954.89	7,520.10	0.386

NOTES

- Data in columns H and J obtained from survey data (see Chapter 7).
- Column C = £1,000,000 / 1.15 = £869,565.22.
- Column D = column B – column C.
- Column F = column E / 1.15
- Column G = column E – column F.
- Column K uses formula 5.2 to identify the 'new' utility of the additional contractor's trade.
- Column L = column K – column D.
- Column M = column L / column G.

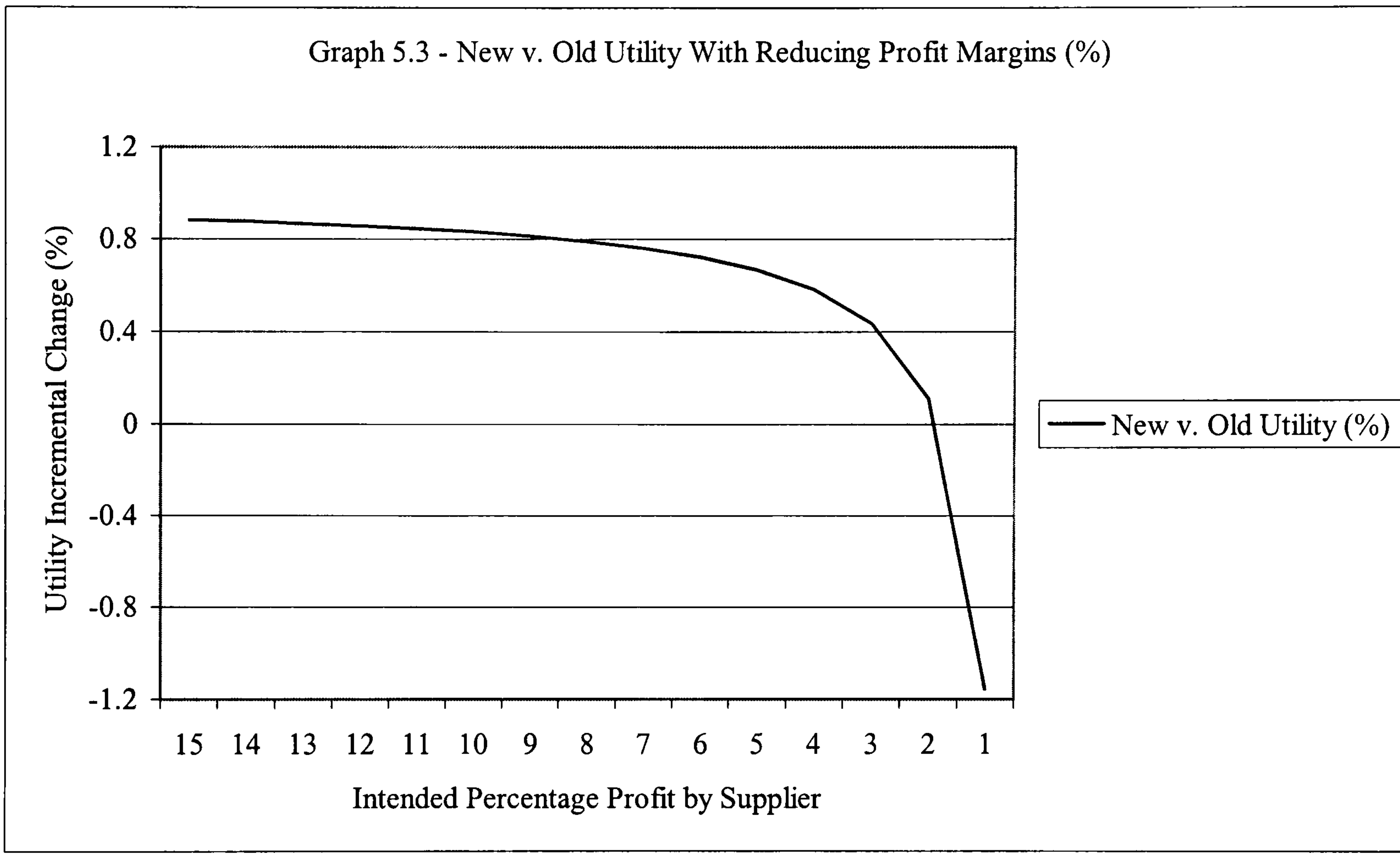
curve identifies that when credit allowed to this contractor exceeds 15 per cent of the supplier's turnover, the utility gained reduces at a significantly faster rate *ceteris paribus.*



5.4.5 Scenario three

This is as per scenario one, but with the probability of bad debt remaining constant and percentage profit margin being incrementally reduced from 15 to zero per cent in one per cent increments. Graph 5.3 and Table 5.3 show that as profit margins reduce, so does the utility gained (by the supplier) from the additional trade of a contractor. The rate of reduction is less prominent when small reductions on a large profit margin apply. When profit margins are smaller, small changes in profit margin result in significantly larger negative changes in utility.

Only three scenarios have been detailed in this example, but when applying Bernoulli's formula to 'other' creditor and debtor characteristics it has shown that 'adjustments' to supplier turnover, probability of bad debt and amount of credit furnished, characteristics displayed in the scenarios described are representative.



5.4.6 Findings of utility model

When considering the three worked examples given, the findings of analysis highlight the following:

i. The accuracy of a potential debtor's creditworthiness is directly related to the potential (supplier) utility gained from that trade. The greater the accuracy, the higher the potential utility when the additional trade is undertaken.

Table 5.3
Scenario Three: Turnover and Probability of Bad Debt Remain Constant but With Reducing Profit Margins

(A) Observation Number and Profit Margin Aimed For in Parenthesis	(B) Suppliers Turnover	(C) Cost of materials to supplier	(D) Supplier's present profits	(E) Contractor's Credit Requirements	(F) Cost of materials to supplier for contractor under consideration	(G) Targeted profit to be made from additional trade	(H) Probability of contractor honouring debts	(J) Probability of Contractor not honouring debts	(K) Utility value of additional trade plus original turnover	(L) Utility value of new contractor's trade	(M) Utility profits / Actual Profits
1 (15)	1,000,000.00	869,565.22	130,434.78	5,333.00	4,637.39	695.61	98.5	1.5	131,048.75	613.97	0.883
2 (14)	1,000,000.00	877,192.98	122,807.02	5,333.00	4,678.07	654.93	98.5	1.5	123,380.20	573.18	0.875
3 (13)	1,000,000.00	884,955.75	115,044.25	5,333.00	4,719.47	613.53	98.5	1.5	115,575.91	531.66	0.867
4 (12)	1,000,000.00	892,857.14	107,142.86	5,333.00	4,761.61	571.39	98.5	1.5	107,632.24	489.38	0.856
5 (11)	1,000,000.00	900,900.90	99,099.10	5,333.00	4,804.50	528.50	98.5	1.5	99,545.41	446.31	0.844
6 (10)	1,000,000.00	909,090.91	90,909.09	5,333.00	4,848.18	484.82	98.5	1.5	91,311.52	402.43	0.830
7 (9)	1,000,000.00	917,431.19	82,568.81	5,333.00	4,892.66	440.34	98.5	1.5	82,926.51	357.70	0.812
8 (8)	1,000,000.00	925,925.93	74,074.07	5,333.00	4,937.96	395.04	98.5	1.5	74,386.15	312.08	0.790
9 (7)	1,000,000.00	934,579.44	65,420.56	5,333.00	4,984.11	348.89	98.5	1.5	65,686.08	265.52	0.761
10 (6)	1,000,000.00	943,396.23	56,603.77	5,333.00	5,031.13	301.87	98.5	1.5	56,821.71	217.93	0.722
11 (5)	1,000,000.00	952,380.95	47,619.05	5,333.00	5,079.05	253.95	98.5	1.5	47,788.26	169.22	0.666
12 (4)	1,000,000.00	961,538.46	38,461.54	5,333.00	5,127.88	205.12	98.5	1.5	38,580.67	119.13	0.581
13 (3)	1,000,000.00	970,873.79	29,126.21	5,333.00	5,177.67	155.33	98.5	1.5	29,193.37	67.16	0.432
14 (2)	1,000,000.00	980,392.16	19,607.84	5,333.00	5,228.43	104.57	98.5	1.5	19,619.36	11.51	0.110
15 (1)	1,000,000.00	990,099.01	9,900.99	5,333.00	5,280.20	52.80	98.5	1.5	9,839.87	-61.12	-1.157

NOTES

- Data in columns H and J obtained from survey data (see Chapter 7).
- Column D = column B – column C.
- Column F = column E / 1.15
- Column G = column E – column F.
- Column K uses formula 5.2 to identify the 'new' utility of the additional contractor's trade.
- Column L = column K – column D.
- Column M = column L / column G.

ii. The greater the quantity of financial credit required by a single contractor is related to suppliers' potential utility 'risk' via a hyperbolic function of the present profits made by the specific supplier.

iii. Continually reducing profit margins result in hyperbolic changes in utility from additional trade undertaken.

These findings are not unexpected, but are uniquely novel in that they are represented in real numbers for the first time. This is something that no other credit limit model has ever achieved. If a supplier is expending resources on collecting debts as well as counteracting losses against profit, then profit maximisation is undermined. When the initial probability of making a profit is 'small' (i.e. small targeted profit margin and / or the quantity of credit required by a contractor accounts for a significant proportion of the supplier's turnover), changes in utility to the supplier are large and potentially negative.

The scenarios detailed have assumed that only one-factor changes at a time. In a real life situation, it would be reasonable to assume that all factors fluctuate simultaneously. Implications of this on utility confirm that it is a highly dynamic variable.

The examples illustrate that careful consideration is required regarding the 'actual' value of contractors' potential trade, when considering suppliers' capacity for bad debts. Because suppliers want to maximise profit (which is normally related to increasing turnover), by allowing a single contractor to build up and account for a large proportion of the supplier's turnover is stymied with hazards.

When considering the factors in Formula 5.2 individually, it can be seen that the most significant variable impacting upon utility achieved from an interaction, is the probability of incurring bad debt. That is, if it were possible to have perfect knowledge (of how a potential debtor was going to act i.e. honour due debts or not), then suppliers would 'only' have to compete against other suppliers to win a contractor's trade. However, because it is presently unknown how a potential debtor is going to act when furnished with credit, the principle of forecasting and predicting the probability of default is required. In turn, this leads to consideration of quantities of credit allowed, as well as desired supplier profit margins. Inevitably, the greater the probability of incurring bad debt the greater the risk of financial exposure. In all, these observations highlight the need for this research i.e. to accurately measure potential debtors' creditworthiness.

Targeted profit margins form a balance between the risk creditors expose themselves to and potential utility gained from that additional trade. Profit margins are a creditor's method of justifying this risk. It would not be unreasonable for a supplier to seek greater profit from a contractor who has been designated a higher credit risk. The converse could also be true. This is analogous to risk mark-up or reduction on tenders.

The main conclusion to draw from this chapter is that highest risk suppliers:

i. interact with a small number of contractors;
ii. operate on small profit margins;

iii. have poor creditworthiness evaluation procedures; and

iv. that failure of one contractor to honour their debts can result in the anticipated utility being negated and the supplier incurring financial loss.

5.5 VALIDATION OF UTILITY MODEL

To validate the utility concept presented in this chapter, internal validation was embraced:

Internal validation uses three 'domains' for gaining information on a subject. The three domains are: literature search; questionnaire survey; and model development (Checkland, 1981; Erlandson, et al., 1993). When the three dimensions show similarity in all three dimensions, then it is accepted that the 'new' dimension (utility of credit risk in this particular case) is validated. Because similarities and convergence were shown in the three dimensions the utility model gained internal validation.

The utility concept was also 'tested' to see if it produced consistent and expected results. The concept produced consistent results for different supplier and contractor characteristics and the tendency of these results was as expected. Hence, as far as one can in empirical terms, the concept was validated.

5.6 SUMMARY

Present methodologies for defining the credit limit of a potential debtor represent an inexact science. These methodologies tend to rely upon debtors' financial characteristics; little consideration is given to the financial characteristics of the crediting organisation. Present methodologies for defining credit limits of potential debtors are flawed in this respect. To address this problem, a model has been presented able to take into account, both the creditor's and debtor's mutual needs and characteristics.

Formula 5.2 has highlighted that an accurate analysis of a potential debtor possibly defaulting on repayment is required. It is evident that the quantity of potential profit resulting from interacting and furnishing credit must also be considered, along with the probability of the contractor defaulting on payment and the quantity of materials allowed on credit.

Associating utility with credit assessment is complex. Because utility is a highly individualistic trait the decision to grant a potential debtor credit is ultimately at the discretion of the supplier. However, with the knowledge of potential gains and losses (as highlighted in this chapter) the notion of such discretion on 'gut feelings' alone is reduced, and replaced to a significant extent with decisions based on qualitative and quantitative knowledge. To determine suppliers' risk exposure, accurate creditworthiness procedures are required. The quantity of credit given should also be evenly distributed among those contractors with whom the supplier trades, or intends to trade with.

Having now presented a number of salient observations on improving the accuracy of contractor creditworthiness and associated impacts for creditors, the next chapter describes the construction of a national UK survey of suppliers' credit control and debt collection procedures. The rationale for this survey was that the findings to be gained will assist in gaining knowledge concerning generic variables *D* and *Cr* of the conceptual contractor creditworthiness evaluation model (Formula 3.3). Because these variables are influenced by the utility a supplier experiences from a potential business interaction, the survey has the potential to provide information in a number of research domains required.

CHAPTER 6

SURVEY DESIGN AND IMPLIMENTATION: MATERIALS SUPPLIERS' CREDIT CONTROL AND DEBT COLLECTION PROCEDURES

6.1 INTRODUCTION

This chapter outlines the rationale underpinning a questionnaire survey of materials suppliers operating in the UK construction industry. The objective of the survey was to: i) identify procedures presently being used by suppliers to evaluate contractors' creditworthiness; and ii) observe and better understand these crediting organisations' methods of debt collection. Reasons behind these objectives were threefold:

i. The literature review had identified that present creditworthiness evaluation models and procedures (for all sectors of industry) utilised bespoke and static procedures, this subsequently leading to inaccuracies and increased financial risk levels for creditors. This observation needed to be formally 'confirmed' by materials suppliers (creditors).
ii. Stemming from point (i), the survey aimed to highlight the need for an accurate construction contractor creditworthiness model to be developed.
iii. The survey allowed communication with materials suppliers. Thus, the foundations for future sources of information and collaboration regarding

suppliers' credit control and debt collection procedures were placed. The survey also notified suppliers that research was being undertaken into contractor creditworthiness evaluation.

This chapter details the:

- survey sample design;
- objectives of the questionnaire;
- reasons for asking particular questions within the questionnaire; and
- proposed data evaluation methodologies for responses to the survey.

First however, the reasons for deciding to use a survey questionnaire are detailed.

6.2 SURVEY RESEARCH METHODOLOGY

The reasons for utilising a structured, postal questionnaire survey for gaining information from suppliers regarding their contractor creditworthiness evaluation procedures and debt collection methodologies were as follows:

- At present (2000), no research findings exist that specifically detail the methods used by materials suppliers for evaluating construction contractors' creditworthiness. There is also a lack of research relating to the methods employed by suppliers for collection of financial debts.
- A questionnaire survey allowed communication to be initiated between the researcher and a broad spectrum of materials suppliers. This initial contact may

be useful when details of contractors' behaviour for materials purchased on credit is considered in (potential) future research.

- A postal survey questionnaire was the most economical method, both in terms of time and finance consumption (when compared to 'other' methods) of gaining the desired information from a 'large' sample of suppliers.
- A postal survey questionnaire allowed a UK nation-wide survey of materials suppliers to be undertaken, thereby indicating possible geographical regional trends associated with evaluation procedures.

Methodologies that were considered for collection of the required data, but were discounted (as failing to provide the necessary quantity and quality of feedback within time and cost constraints allowed) are now detailed.

- *Process observation:* there would be little learned from simply observing current 'physical' methods employed by suppliers for:
  i. evaluating contractors' creditworthiness; and
  ii. debt collection methods.

  Further, and predominantly, the time consumption that this method of data collection would take is unacceptably high in this specific context (see Holt, 1998).

- *Process measurement*: time and cost constraints are preliminary obstacles when using this methodology of data collection. Further, it was unlikely that materials suppliers would have had the time to explain the methods used in evaluating a contractor's creditworthiness, and / or the methods being employed for debt collection (ibid.).

- *Open question survey*: time and cost constraints restricted this methodology being used for data collection. Also, there was the probability of gaining as many different responses as survey respondents. Because of the probability of gaining such a 'spread' of answers, analysing the responses quantitatively, would be difficult (ibid.).

- *Unstructured interview*: time and cost constraints prevented this methodology from being used. Further, there was a possibility that the interview would go off at a tangent to which the survey intended. This would result in responses to interviews being 'unusable' in relation to the nature of the data collected (ibid.).

- *Structured interview*: time and cost constraints again made this methodology of data collection unsuitable; this is due to textual (transcript) data being of little use for the overall methodology associated with this particular research project (ibid.).

The removal of these methods of data collection identified that a 'structured postal questionnaire' survey was the most suitable method in achieving the aims, and objectives of this research project.

6.2.1 Sample design of targeted survey suppliers

Because realistically it is physically and practically impossible to supply *all* UK materials suppliers with a survey questionnaire for this research project, it was necessary to identify a representative sample of suppliers for inclusion. Indeed, statistical concepts mean that proper sampling of the population means that one does not need to approach the entire population. Careful sample design also meant that inferences drawn from the returned questionnaires would be reliable and statistically well grounded. Three organisations were initially identified as having regular contact with 'large' numbers of materials suppliers. These organisations being:

- The Institute of Builders Merchants;
- The Institute of Materials Management (now Institute of Logistics); and
- The Builders Merchants Federation.

By being associated to one or more of these organisations, identified that a supplier was (tentatively) interested in up-to-date issues in the building industry and their associated affects upon their organisation's existence and hence prosperity. It was therefore decided that the sample would be purposely skewed towards organisations that were interested in contractor creditworthiness evaluation, and would be concerned about removing the presently un-quantified financial risk element in allowing contractors credit. Furthermore, it was hypothesised that organisations affiliated to the three mentioned institutes would be more conscientious in the procedures they employed for contractor creditworthiness evaluation; in contrast to organisations that were not members. The reasons for these lines of thought were that to become members of the organisation(s) listed, suppliers had to prove their competence by remaining in business for a considerable period of time and have achieved a minimum capital turnover per year. In general, criteria like these were unlikely to be met by suppliers of 'dubious' trading nature.

These three organisations were contacted, but were unwilling to assist in this research. Hence, a new line of enquiry was taken. It was decided that materials suppliers would be selected from the Kompass directory (1996-7).

The Kompass directory is an annual publication that contains information on various trading organisations in the United Kingdom. The directory's function is to collate organisational (commercial) information into one source. Organisational information includes: the date the company was established; name(s) of directors; annual financial turnover; number of employees; address of head office; and the principal trading activities; amongst other organisational facts.

An important factor to consider is that some organisations may have considered the option of 'advertising' in the Kompass directory, as being superfluous to their needs, or not worthwhile at the particular time the survey participants were identified. Because of this implication, there was the possibility that certain materials suppliers, who have the correct 'criteria' for being selected for sample inclusion would be excluded from the survey sample. Though this is a drawback, the majority of 'large' financial turnover (£) UK materials suppliers' relative details were included in the Kompass directory. Furthermore, to negate the numbers of suppliers that would not have their details included in the Kompass directory, the nature of supplying materials to the construction industry intrinsically means that advertising is now an accepted method of company promotion. Chevin (1993) and The Chartered Institute of Building (1993) detailed the advantages of good advertising campaigns for construction contractors. It could be argued that promoting a construction contractor differs from a materials supplier, but the fact remains that the Kompass directory includes details on a large proportion of UK nation-wide and 'large' financial turnover (£) materials suppliers. Therefore, this method allowed materials suppliers to be selected for the sample, who interacted with a wide spectrum of construction contractor trades and who supply the industry with the diverse and different materials that it uses.

Criteria for selection of materials suppliers (i.e. to be included in the sample) are now presented. These criteria are followed by explanation of *why* they were used.

i. must supply roofing and insulation materials, or plumbing materials, or bricks and blocks, clay and concrete and underground drainage materials, or cement and plaster materials, or decorating materials, or ironmongery and associated products, or kitchen equipment, wall and floor tiles, or boards and timber products, or heating materials. And also;

ii. must have been established for a minimum of five years. And also;

iii. have a minimum turnover of £½m. And also;

iv. 'advertise' in the Kompass directory. And also;

v. be associated to one or more of the following organisations: Institute of Builders Merchants; Institute of Logistics; or Builders Merchants Federation.

Though these criteria could have been increased in detail, for example, by only including those organisations which were BS 5750 or ISO 9000 certified, there was a need to retain some form of 'inclusion flexibility'. Too many sample selection criteria would have meant a greatly reduced sample size and hence a reduced number of usable data for analysis.

Reasons for selecting these sample inclusion criteria were as follows.

Point i: This identified the 'type' of materials the organisation supplied to the construction industry. By not incorporating this factor, a large number of 'other' types of suppliers may have been included in the sample e.g. equipment suppliers, plant suppliers etc. This criterion ensured that the sample **did** interact with construction contractors and hence, by definition, had to carry out some form of contractor creditworthiness evaluation, as well as debt collection.

Point ii: The five years minimum establishment time was used because this indicated that the supplier organisation was capable of making effective decisions regarding trading arrangements and maintaining their bad debt within allowable tolerances, i.e. the ability to remain profitable, and hence, in business.

Point iii: A minimum turnover of £½m identified that organisations were still trading and were not simply an organisation name used by a parent company for tax purposes.

Point iv: Failure to be included in the Kompass directory would have resulted in insufficient information being available regarding each potential supplier's business characteristics. Therefore, no definitive conclusions could have been obtained regarding the whether a supplier satisfied the necessary criteria for being included in the sample.

Point v: Company membership of professional organisations: this point has been referred to previously.

6.2.2 Questions included in the survey questionnaire and why

The literature review highlighted the inadequacies of present methods of evaluating potential debting organisations' creditworthiness (see chapter 2). When summarising the literature review it was identified that:

- present methods of contractor creditworthiness evaluation relied greatly upon past trading records and financial accounts of the potential debtor;
- no consideration was given to future 'booms' and recessions that the economy may suffer; and
- the potential debtor's management philosophy regarding payment for goods on credit was not taken into account, neither was the probability of increased competition in the building industry.

Having made these observations regarding present potential methods of creditworthiness evaluation, survey questions were designed, amongst other factors, to determine suppliers' attitude towards present creditworthiness evaluation procedures. An example of the questionnaire distributed to targeted materials suppliers is included in Appendix 6.1. Individual questions are now detailed and reasons given *why* such questions were asked.

Question 1 – Please tick the box(es) opposite the classification(s) that best represent the type of contractors your organisation supplies materials to - Identified the 'type' of construction trades and contractors that suppliers traded with. Responses to this question had the potential to identify if there were different characteristics shown by the various classifications of contractors with whom suppliers traded; in particular, regarding the contractors' payment habits for goods on credit.

Question 2 – Please tick the box(es) next to the region(s) where contractors you supply materials to are located - Identified the area of the UK that the supplier supplied materials to. This factor potentially allowed regional payment and creditworthiness analysis characteristics to be identified. It was hypothesised that that due to the sample of targeted suppliers being skewed towards long (time period) established organisations, that there would be a tendency to gain more responses from organisations trading on a UK nation-wide basis than compared to local geographical regions. The reason for this line of thought was that the criteria for being included in the sample, had tentatively only selected long established businesses. Because of this, it was generalised that these organisations should have had the opportunity to expand their business and hence potential contractor client base, in both size and geographical distribution.

Question 3 – Please tick the box next to the category that best represents the total sales turnover of your organisation in the last financial year - Identified the annual financial turnover (£) of the materials supplier. This would allow analysis to be carried out regarding whether 'larger' financial turnover (£) suppliers, used different creditworthiness evaluation procedures, compared to 'small' financial turnover suppliers.

Question 4 - Please indicate the percentage growth / contraction in sales turnover your organisation has experienced over the last three financial years. Denote growth with a '+' and contraction '-' prior to the percentage figure e.g. 6% growth = +6% - Identified the trend in capital turnover of the supplier over three years trading (1995-6, 1996-7 and 1997-8). From this observation, there is a possibility that those suppliers who exhibited successive growth in turnover could be discriminated against those suppliers who experienced contraction in growth; this discrimination could take place with respect to the suppliers' methods employed for contractor creditworthiness evaluation and debt collection.

Question 5 – Please tick the category that best represents the number of credit accounts your organisation had with contractors in the last financial year - Identified the number of credit accounts that the supplier furnished to contractors in the previous (1997-8) financial year. By gathering this data, future possible research could identify any relationship between the number of credit accounts furnished and the physical quantity of credit furnished each 'creditworthy' contractor.

Question 6 – What proportion of your total sales is accounted for by contractors using credit offered? - This question complements question 5 and allowed the percentage of suppliers' turnover that is accounted for by credit sales to be identified. Failure by survey respondents to indicate that credit sales accounted for a 'large' percentage of their (suppliers') turnover would indicate that there was little need for this research.

Question 7 – Do you check on the creditworthiness of contractors before granting them credit? - Identified whether suppliers *did* carry out any form of contractor creditworthiness evaluation before granting credit. If no evaluation was carried out, then a comparison could be made between those suppliers who did use some form(s) of creditworthiness evaluation and those suppliers who did not. This is with particular regard to identifying if there was any statistically significant difference in the amount of bad debt incurred.

Question 8 – What percentage of those contractors allowed credit, do you establish credit limits for? - This investigated the percentage of creditworthy contractors that suppliers imposed credit limits on. Reasons for requiring this information were that it could allow research to be conducted regarding the difference between 'contractor creditworthiness' and credit limits imposed on contractors. That is, are there any differences between a contractor being classified as 'creditworthy' and the physical amount of credit that is furnished an organisation?

Question 9 – How do you establish the credit limit for each contractor? - Obtained information relating to how suppliers carried out contractor creditworthiness evaluations. Responses to this question also indicated whether suppliers used an 'external' organisation to advise them on the amount of credit they should allow a contractor, or whether the supplier in question defined a credit limit based on their own perception of credit risk.

Question 10 – What sources and methods do you use for checking the creditworthiness of contractors? - Here, information relating to which method(s) suppliers used and preferred for contractor creditworthiness evaluation was sought. Those sources / methods used for such a task were then intended to be ranked by suppliers in order of perceived accuracy (of the evaluation method stated). Responses to this question had the ability to reinforce the need for research into contractor creditworthiness evaluation, because if users (suppliers) were 'unhappy' with their present methods, then this would justify the research.

Questions 11 and 12 – How much time on average (operative hours) does your company spend evaluating each contractor's creditworthiness? and *How much money (on average) does your company spend when evaluating a contractor's creditworthiness?* - These questions investigated what resources (time and cost) suppliers were investing in evaluating creditworthiness. Responses to these questions would provide an indication regarding resource constraints that any potential 'new' contractor creditworthiness model should operate within (it is recognised that increased creditworthiness evaluation accuracy may incur costs above those indicated at present).

Question 13 – Do you have a separate credit control department? If yes, what does this department cost your organisation in terms of percentage turnover per annum? - Investigated what proportion of suppliers' turnover, their credit control departments cost to operate. This information had the ability to indicate whether suppliers perceived their credit control department as being 'important' and worthy of being assigned financial support.

Question 14 – What are your organisation's standard terms of payment? - This question sought information relating to suppliers' standard terms of payment (imposed on contractors once materials have been purchased on credit). This information allowed potential investigation of whether evaluating contractor creditworthiness was too complicated a continuum, and that speedy collection of debt was inimical with controlling bad debt.

Question 15 – Does your organisation offer discounts for prompt payment? - This question complemented question 14 and sought information regarding whether suppliers offered some form of financial inducement, to 'persuade' contractors with credit to make payments at desired dates.

Question 16 – What was the percentage of bad debt to sales in your last financial year? - Data relating to suppliers' amount of bad debt incurred in financial year 1997-8 was sought. This information was required as it (potentially) allowed the need for this research project to be highlighted: the greater the amount of bad debt incurred, then the greater the need for improving the accuracy of contractor creditworthiness evaluation.

Question 17 – What percentage profit do you aim to make before bad debt is allowed for? - This question sought to identify the percentage of profit suppliers aimed to make before bad debt was taken into account. This observation was important because it could indicate whether suppliers 'protected' themselves somewhat from the impact of bad debt by demanding 'large' percentages of profit from materials sold.

Question 18 – Do you have a standard procedure for collecting overdue accounts? - This question sought information relating to suppliers' methods of collecting overdue accounts. It asked which debt collection procedures suppliers used, how many times the procedure had been used in the previous financial year (1997-8), after what period the debt collection procedure was implemented, and the response to the debt collection procedure by the debtor.

Question 19 – Do you insure against bad debt? - Responses to this question would indicate if suppliers protected themselves from bad debt by taking out insurance against such occurrences. Because different 'levels' of bad debt insurance can be obtained, a sub-question was asked. The sub-question asked the percentage of repayment that would be received from an insurance organisation upon the supplier incurring a bad debt.

Question 20 – Do you factor any or all of your debts? - This question was similar to question 19 and sought to observe suppliers' attitude towards factoring of their debts. Because it had been reported that factoring of debts had increased over recent years

(Agapiou, et al., 1998b), this data could determine whether this detail was correct for UK materials suppliers.

Question 21 – As a percentage of CREDIT sales, what do you consider the maximum acceptable percentage lost on bad debts? - Responses to this question indicated what percentage of bad debt could occur from credit sales *and* be within an 'acceptable' tolerance level for suppliers. It was envisaged that suppliers who furnish credit have to reconcile this risk and potential bad debt against the advantages of gaining the trade and hence profit from contractors who do honour their debts.

Question 22 – Is it your policy to reassess the creditworthiness of contractors? - This question sought to identify if suppliers ever reassessed the creditworthiness of potential debtors, and if so at what intervals. Reasons for asking this question were that the definition of creditworthiness being used for this research project (see chapter 2) had suggested that organisations that are creditworthy at one point in time, may become 'uncreditworthy' in future periods.

Question 23 – What would be the reasons for reassessing contractor creditworthiness? - Responses to this question complemented responses to question 22, and specifically asked suppliers what reasons would be used as a basis for reassessing contractors' creditworthiness.

Question 24 – If a contractor placed a substantial order would your organisation ask for guarantees of payment? - Suppliers were asked if a substantial sized (£) order being placed by a contractor would result in them asking for guarantees of payment.

Reasons for asking this question were that it allowed knowledge to be gained regarding the amount of potential debt a supplier exposes themselves to, and their respective attitude towards this risk.

Question 25 – Do you consider your present creditworthiness evaluation procedure to be acceptable? - Questioned whether suppliers considered their present creditworthiness evaluation procedures as acceptable. This was asked becasue responses had the ability to indicate whether suppliers' perception of their current creditworthiness evaluation and debt collection procedures were acceptable, or not.

Question 26 – Would your organisation consider providing (in confidence) data on contractors payment behaviour for materials on credit? - Suppliers were asked if they were willing to provide data relating to contractors' payment behaviour for materials purchased on credit. This information was necessary to build a model based on the characteristics of contractors, i.e. what characteristics of a contractor suggest that they would be 'good' at honouring their debts, as opposed to 'average' or 'poor'?

Having detailed the questions included in the questionnaire, and the reasons for asking them, the questions were then incorporated into the questionnaire. To ensure that the survey was 'easy' to follow and had suitably stratified response categories to gain maximum potential benefit from the survey, a pilot survey was conducted. The pilot survey and questionnaire distribution is now detailed.

6.2.3 Questionnaire distribution and pilot survey

For statistically acceptable results to be obtained from a survey questionnaire Alreck and Settle (1995 p.62) suggest that 100 responses is normally the minimum number required to be evaluated, whilst the 'practical' maximum number of responses is 1,000. However it is accepted in certain texts that 40 responses produce a statistically good grounding and have the ability to portray the populations characteristics correctly (Oltman and Lackritz, 1991). Though there is no theoretical maximum number of responses that could be evaluated, survey response numbers in excess of 1,000 questionnaires fail to produce any greater accuracy of results. It was initially assumed that the response rate to the survey would be between 25 and 50 per cent. This identified that 400 materials suppliers had to be sent a questionnaire to obtain the 'minimum' acceptable response numbers.

To ensure the questionnaire's derivation and layout was simple to follow, whilst still providing sufficiently detailed data for evaluation and future 'model building', a pilot survey was undertaken. The pilot survey consisted of randomly selecting ten materials suppliers from the list of suppliers who had been complied with the targeted survey inclusion criteria.

The organisations who were selected to be used for the pilot survey are not detailed for confidentiality reasons. However, Appendix 6.2 contains the covering letter that accompanied the pilot survey.

Response to the pilot questionnaire was 30 per cent. From these responses the questionnaire was adjusted slightly to take into account how crediting organisations ascertained credit limits for creditworthy contractors, and if suppliers offered discounts to contractors for prompt payment. That is, a response category in question 9 was added relating the duration of relationship between supplier and contractor; and question 15 was re-written to allow different discount percentages to be detailed by responding suppliers.

Following the pilot survey, the questionnaire in its revised form was sent by post to 365 materials suppliers who had complied with the survey inclusion criteria. Though the response rate may have been greater if prior contact had been made with the survey targeted suppliers, resource constraints deterred such actions. However, the questionnaire was accompanied with a covering letter and a brief document detailing *why* there was a need for the research and the advantages to be gained from suppliers participating in the survey. Examples of the letter and briefing document are included in Appendix 6.3. The content of the letter and brief was, it was hypothesised, of vital importance in encouraging supplier survey responses.

Returned questionnaires were collected on a daily basis and the date that they were received noted on the final page. A record was kept detailing suppliers who had been sent a questionnaire, and the date the questionnaire was returned. By maintaining this record it was possible to determine the survey response rate at any point in time and any suppliers that needed to be contacted to increase the total survey response rate e.g. follow-up telephone calls and / or letters.

6.2.4 Questionnaire sight-editing documents

Each returned questionnaire was sight-edited. This process included examination of the returned document to determine if it was acceptable for processing i.e. had a sufficient number of questions been answered? Each returned questionnaire was also 'speed read' to identify if respondents had completed the questions as was requested. There was always a possibility that respondents would not answer all of the questions in the survey. Hence, it was decided that the maximum number of unanswered questions, whilst still allowing the response to be included in future analysis was three questions. Three unanswered questions represented over ten per cent of the questions in the questionnaire and hence, this was considered to be a sufficiently large shortfall for this purpose.

Data from acceptably completed returned questionnaires was then inserted into a Microsoft Excel spreadsheet. The reason for using a spreadsheet was that the total number of responses to each response category could be easily derived. Further, since the software that was going to be used for future analysis on the response survey data was Statistical Package for the Social Sciences (SPSS) data in Microsoft Excel format had the ability to be 'easily' transformed into this statistical software package.

Having considered what number of questions needed to be answered in order to be included in future analysis and what format survey responses would be saved in, to allow future analysis to be carried out, potential methods of statistical analysis were then considered.

6.3 SURVEY DATA ANALYSIS

From the constructed spreadsheet of the survey responses, initial statistical analysis was conducted to allow greater understanding of interrelationships between survey questions and responses gained. However, prior to conducting any statistical analysis, the 'nature' of the survey data needed to be known. Alreck and Settle (1995 pp.255) described and gave examples of four different scales and data types: nominal, ordinal, interval, and ratio.

Nominal scale: each possible category in a question is assigned a number. By converting the possible answers into numerical codes it allows subsequent computer analysis to be carried out quickly and efficiently.

Ordinal data: ordinal-scaled data occurs when a question asks for items to be ranked in comparison to each other. This process cannot be legitimately used for statistical verification in mathematical equations (Alreck and Settle, 1995 p.257). However, it does allow identification of 'preferred' answers in relation to other possible responses. Because it is unknown how greater the respondent preferred one answer to another it identifies that non-parametric statistical testing is required upon this data. Meddis (1984) describes a number of statistical procedures that can be used to 'interrogate' ordinal data and identify statistically 'interesting' relationships amongst the analysed data.

Interval data: this scale allows variables to be measured on an independent scale. Typically, this scale is used for scoring potential responses in terms of what is preferred, or desired more than another item. It is worth noting that the intervals between possible data responses are not identical e.g. a response of '4' does not necessarily mean twice as much 'preferred' as a response rated '2'.

Ratio scale: ratio scales are akin to interval data except that there is a 'real zero'. The second difference being that the intervals between the variables are identical e.g. a response rated '4' represents twice as much as a response rated '2'.

Having determined the nature and scales applicable to the data provided by the survey, consideration was given to the methods to be used for analysing these data.

6.3.1 Analysing survey results

Statistical methods for analysing the survey data were important to consider at an early stage, e.g. during questionnaire design. Failure to use the 'optimal' and most suitable analyses may result in the data being incorrectly interpreted and wrong inferences being drawn.

The most elementary statistical analysis procedure is percentage distribution. It allows a broad overview of the survey response answers. Further, interpretation of percentage observations is relatively easy.

Expanding percentage analysis slightly further, it is possible to identify the mean, median and mode of the population sample(s) for central tendency. From the analysis methods discussed so far it was possible to deduce how the sample was distributed i.e. normal or skewed (positive or negative) (see further Alreck and Settle, 1995 pp. 276-277). Standard deviations could also be calculated for the survey response data.

Standard deviations have the ability to indicate the measure of dispersion about the sample mean. The smaller the standard deviation figure the closer the spread about the mean the data is, and vice versa for a large standard deviation. Data with a small standard deviation intrinsically infers that conclusions drawn from it are more reliable / accurate than if a large standard deviation were present.

To gather further information from the questionnaire, relationships between question responses could be considered. Caution is necessary when evaluating association between survey responses, as this does not always mean causation. The degree of association between survey responses was identified by correlation analysis.

Due to the importance of the survey responses in this thesis they have been designated their own chapter (chapter 7). Further, the survey responses have also been modelled using multi-variative discriminant analysis (MDA); results of this 'modelling' are presented in chapter 8.

6.4 FEEDBACK TO SURVEY PARTICIPANTS

Having evaluated the questionnaires' responses using simple percentage observations and mean, median and mode calculations, a summary report was written detailing the findings of the survey (see Appendix 6.4). The essence of this report was to feedback to materials suppliers, who contributed towards the research, the results of the survey. The reason for maintaining contact with the organisations that participated in the survey was that it may have been of assistance in future research when further details are required about contractors' payment habits for materials purchased on credit, as well as for any derived model validation purposes. Feedback on a more general level to the construction industry was via a paper published in *Building Research and Information* (Nicholas, et al., 2000a). The reasons for two routes of feedback were so that the maximum publicity of the research was gained and hence maximum feedback on the survey findings invited and achieved.

6.5 SUMMARY

This chapter has identified the need for a questionnaire to identify present methods used by materials suppliers when evaluating contractors' creditworthiness.

The optimal method of questionnaire circulation and structure in comparison to other methodologies has been identified as a postal structured survey. Reasons have been given for including questions and how responses to these will indicate future key factors in accurately predicting contractors' creditworthiness. An estimation has been given regarding the number of questionnaires necessary to be circulated to materials suppliers in order to gain a 'statistically valid' number of returned completed forms.

Consideration has been given to the profile of which suppliers should be included in the sample size, as well as possible methods of analysing the survey responses. Further, a discussion regarding feedback to participating materials suppliers and the construction industry on a whole has been detailed.

Having detailed the questionnaire, its distribution, and subsequent analysis that will be carried out upon responses to it, the next chapter of this thesis details initial survey results.

CHAPTER 7

SURVEY ANALYSIS RESULTS

7.1 INTRODUCTION

The previous chapter provided details of the survey design and implementation. This chapter goes on to provide descriptive statistical findings that were obtained from initial analysis of the survey data.

The survey identified methods and trends associated with a predetermined range of suppliers' traits, associated with contractor creditworthiness evaluation and suppliers' debt collection methods. The analysis performed on these data sought to identify the efficiency, or otherwise, of these respective methods and trends. The reason for this investigation was that the literature review had failed to identify which creditworthiness evaluation procedures and debt collection methods were perceived by industry as 'best' at controlling bad debt.

Trend observation highlighted a number of interesting results, including:

- the minimal resources allocated by suppliers to debtor evaluation;
- the 'questionable' methods used for establishing credit limits; and
- the minimal use of insurance and / or factoring, as a means of protection against bad debt.

The findings of this chapter reinforce previous work and findings in this thesis. That is, the survey results indicate that construction contractor creditworthiness evaluation and debt collection procedures have received minimal research attention to date and, that this situation requires addressing. The majority of this chapter was published in Nicholas, et al. (2000a).

7.2 SURVEY BACKGROUND ISSUES

The survey was undertaken at a time of general economic prosperity (1998); which will have influenced responses (e.g. lesser quantities of bad debt, and higher supplier target profit margins). Further, recent legislation in the form of the Construction Act (1996) may have begun to influence contractors' repayment characteristics at the time of survey (e.g. offsetting pay-when-paid clauses [see Barrie, 1998] or pay-when-certified clauses of the less scrupulous contractor [see Klein, 1998]). These economic and legislative impacts were considered when drawing inferences and conclusions from the analysed survey data, and are referred to as appropriate henceforth.

7.3 THE SURVEY

7.3.1 The survey response

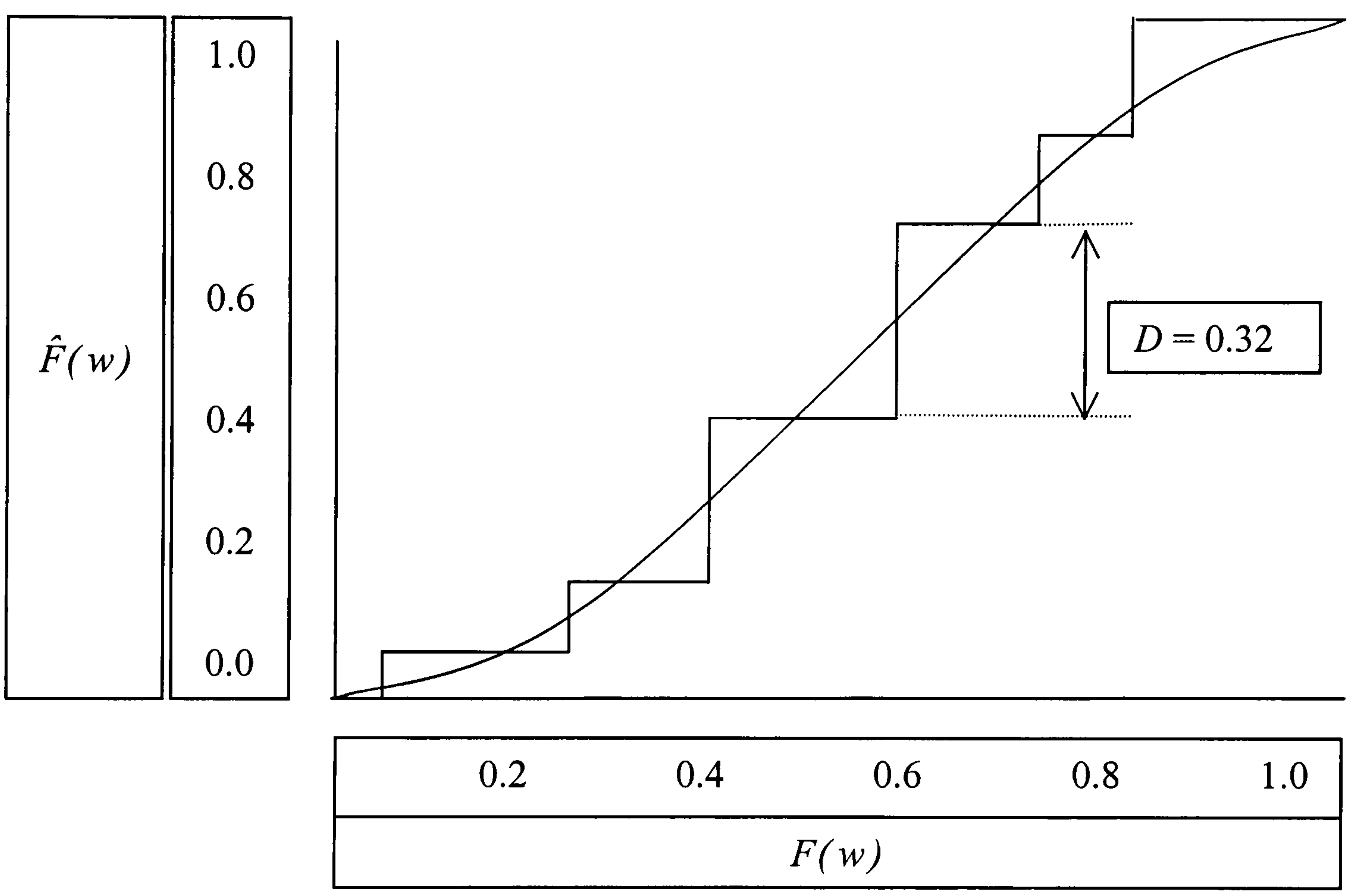
A total of 55 completed questionnaires were returned from the 375 suppliers targeted with the respective document. No returned questionnaires had any more than three questions unanswered. Hence, all returned questionnaires were suitable for use in the analysis. The 'low' survey response rate (15 per cent) was to some extent expected. This is because the questionnaire asked for financial and confidential company information and, that the questionnaire was in itself, quite comprehensive. Though a 'normal' response rate for unsolicited questionnaires surveys is 20 to 40 per cent (Frankfort-Nachmias and Nachmias, 1996 p.226), 55 responses did allow rigorous analyses to be performed (see Oltman and Lackritz, 1991). This is because when samples in excess of 40 in number are obtained, the sample can be reasonably assumed to have such characteristics that are representative of the population under scrutiny (ibid.). Each survey question response was tested wherever possible for normality characteristics (0,1) using the Kolmogorov-Smirnov (K-S) one-sample test. This test has the ability to identify maximum deviation, if any, between observed (survey responses) and a normal distribution (Daly, et al., 1995). The Kolmogorov-Smirnov test is defined via Formula 7.1.

$$D = \max_{0 < w < 1} \left| \hat{F}(w) - F(w) \right| \qquad \text{(Formula 7.1)}$$

Where: D = the maximum vertical distance between the empirical distribution function $\hat{F}(w)$ and the data statistics under consideration $F(w)$; and w = the components of the empirical distribution function and the sample distribution respectively (Daly, et al., 1995 p.495). The Kolmogorov-Smirnov statistic is best explained via the use of Figure 7.1.

It can be seen from Figure 7.1 that when the data set under consideration is standardised and compared to an empirical distribution function, that any differences between the observed and the empirical distribution can be observed. Kolomogorov-Smirnov statistics of '0' indicate perfect correlation between the data sets under consideration. Conversely, Kolomogorov-Smirnov statistics of '1' indicate that the data sets are 'differently' distributed. Because the survey response data was not standardised, significance statistics between the observed and empirical distribution were used to define if sets of survey responses to a particular question were normally distributed.

Figure 7.1
The Kolmogorov-Smirnov Distance



All aggregated question responses failed to exhibit normal characteristics. The 'characteristics' (positive or negative skew) relating to the distribution of survey question responses are indicated and detailed later in the chapter when comments and conclusions are drawn regarding responses to specific questionnaire questions. Because of the data exhibiting non-normal (0,1) characteristics, statistical analysis techniques and procedures used were selected to cope with these characteristics. For example, Spearman's correlation statistics were calculated for the survey response data (this method of data analysis is explained later in this chapter when correlation analysis between responses is detailed).

Analysis and discussion of the survey data is now detailed.

7.4 DATA ANALYSIS

7.4.1 Supplier characteristics

Respondent suppliers furnished credit to a broad range of construction trades. Suppliers predominantly tended to interact (on average) with the following trades:

- 'general building' (23.39 per cent);
- 'roofing and insulation' (19.30 per cent); and
- 'plumbing, heating and ventilation' firms (16.96 per cent).

A full breakdown of these findings is presented in Table 7.1.

Suppliers generally furnished materials to an average of three construction trades (mean value = 3.11). When arranging the classifications of contractors' trades (that suppliers interacted with) in a descending numeric order; plumbing, heating and ventilation contractors were the median construction trade.

Typically, materials were supplied to an average of three or more UK geographic regions, as detailed in Table 7.2. More than ten per cent of suppliers operated on a UK nation-wide basis; the remainder operated regionally. The median geographic region that suppliers supplied materials to was the Home Counties (Nation-wide suppliers excluded from this calculation because they supplied to all UK geographic regions).

Table 7.1
Suppliers: customer base by construction trade classification

Contractor Classification	Number of Materials Suppliers Interacting with Classification of Contractor	Average Percentage of Materials Suppliers' Trade Associated with Classification of Contractor	Cumulative Percentage of Materials Suppliers' Trade Associated with Classification of Contractor
General building	40	23.39	23.39
Roofing and insulation	33	19.30	42.69
Plumbing, heating and ventilation	29	16.96	59.65
Ground work	27	15.79	75.44
Painting and decorating	22	12.87	88.31
Electrical	10	5.85	94.16
Specialist	4	2.34	96.50
Other	6	3.51	100.00
TOTAL	*171*	*100.00*	*100.00*

n = 55 < 171 because respondents serviced several classifications

Mean number of construction trades suppliers interact with = 3.11
Median construction trade that suppliers interact with = Plumbing, heating and ventilation contractors
Mode number of construction trades suppliers interact with = General building contractors

Table 7.2
Suppliers: customer base by UK geographical region

Region	Regional Number of Materials Suppliers Interacting with Contractors	Average Percentage of Materials Suppliers Interacting with Contractors on a Regional Basis	Cumulative Percentage of Materials Suppliers Interacting with Contractors on a Regional Basis
Nation-wide	8	11.43	11.43
Scotland	7	10.00	21.43
Ireland	1	1.43	22.86
Wales	6	8.57	31.43
South West	11	15.71	47.14
Home Counties	10	14.29	61.43
Midlands	12	17.14	78.57
North East	5	7.14	85.71
North West	4	5.71	91.42
East	6	8.57	100.00
TOTAL	*70*	*100.00*	*100.00*

n = 44

Mean number of geographic regions suppliers interact with contractors from = 3.05
Median geographic region suppliers interact with contractors from = Home Counties
Mode geographic region suppliers interact with contractors from = the Midlands

It is interesting to note that 11 survey respondents did not disclose their geographical region of operation. Maybe it is the case that these suppliers had a niche market place in the region(s) that they operated, and did not want to identify this to potential competitors? Another thought is that those suppliers who failed to supply their geographical trading details had not achieved, in their own view, a sufficiently large financial turnover quantum that they considered 'acceptable' to trade on such a geographic basis? Obviously, there are a number of hypotheses that could be suggested for the response to this question, all of which might justify future research.

Table 7.3 shows that the survey response data captured a large cumulative financial value of suppliers' trade. Based on the median for each turnover category in Table 7.3, (and taking £25m as maximum turnover value for the final category) total turnover for the respondent sample was conservatively estimated at £466.25m. This is a conservative estimate because some suppliers who returned the questionnaire had turnover well in excess of £25m. This fact is known because certain suppliers were common 'household names' and cursory reviews of previous years' accounts for these suppliers' had reinforced the fact that their turnover was well in excess of this sum.

Respondent suppliers had an average turnover of almost £9m; whilst suppliers with turnover ranging from £2m to £6m was modal. The standard deviation of respondents' turnover was £8.98m. This fact, combined with the mean turnover figure indicated a positively skewed distribution. From this knowledge it suggests that there are a greater number of suppliers with turnover less than £9m per year than compared to suppliers with turnover in excess of this sum. The Kolomogorov-Smirnov statistic confirmed that the sample relating to suppliers' financial turnover was not normally distributed.

Table 7.3
Suppliers' financial turnover

Financial Year 1997 – 98 Turnover	Number of Materials Suppliers	Weighted Median Cumulative Total Turnover
Up to £½ million	2	£0.50m
Over £½ and under £1million	7	£5.75m
Over £1 and under £2million	5	£13.25m
Over £2 and under £6million	20	£93.25m
Over £6 and under £12million	6	£147.25m
Over £12 and under £16million	2	£175.25m
Over £16 and under £25million	2	£216.25m
Over £25 million	10	£466.25m
TOTAL	*54*	*£466.25m*

Mean financial turnover = £8.63m
Median financial turnover = Over £2 and under £6million
Mode financial turnover = Over £2 and under £6million
Standard deviation = £8.98m
Kolomogorov-Smirnov statistic = 2.40 (0.00 significance)

7.4.2 Suppliers' sales turnover

Suppliers' mean financial turnover trend showed growth for the periods 1995-6, 1996-7 and 1997-8 being 3.58, 6.10 and 7.88 per cent respectively. Reported financial turnover contraction reduced in number from 11 suppliers in 1995-6, to five in 1996-7 and four in 1997-8. Only one respondent experienced three years of continued contraction. Two respondents suffered trading reductions over two consecutive years. It would appear therefore, that the survey was performed following three years of buoyant construction demand.

7.4.3 Number of credit accounts

One-third of respondents serviced ≥ 1,001 credit accounts (Table 7.4). Logically, organisations with ≥ 1,001 credit accounts were those with an annual turnover > £6m. There were large differences in terms of average credit value for each account furnished; ranging from approximately £1,800 to > £25k per debtor, per year. This observation was made by considering: suppliers' financial turnover; the percentage of credit sales that the supplier had in comparison to their turnover; and the number of credit accounts that they furnished.

Table 7.4
Number of credit accounts furnished by suppliers

Number of Credit Accounts Furnished	Number of Materials Suppliers	Cumulative Number of Materials Suppliers
51 – 100	4	4
101 – 300	9	13
301 – 500	10	23
501 – 1,000	13	36
1,001 and over	18	54
TOTAL	*54*	*54*

Mean number of credit accounts furnished = 626.85
Median number of credit accounts furnished = 501-1,000
Mode number of credit accounts furnished = 1,001 and over
Standard deviation = 338.59
Kolomogorov-Smirnov statistic = 1.59 (0.01 significance)

The average number of credit accounts furnished by respondents was 626.85. The median number of credit accounts furnished fell within the class 501 to 1,000; whilst the most often number of credit accounts furnished was 1,001 and over. In this respect, the standard deviation when considered in conjunction with the mean indicates that two standard deviations either side of the mean captures all the responses for this particular characteristic. This indicates that 95 per cent of suppliers would have credit accounts that range between 51 and 1,001 and over. The

Kolomogorov-Smirnov statistic identifies that the number of credit accounts furnished does not exhibit normal characteristics.

7.4.4 Credit sales to turnover ratio

Approximately 60 per cent of respondents' credit sales accounted for over 70 per cent of their turnover (Table 7.5). Suppliers with turnover ≥ £2m ≤ £6m, showed a proportion of credit sales to turnover greater than all other supplier financial turnover categories (> £25m category excluded here, because an upper limit for this class is unknown). It is assumed that because of this fact, suppliers with turnover in the class £2 - £6m are proportionally most at risk from bad debt due to their greater proportion of credit *in relation to their total financial turnover* (ceteris paribus).

Table 7.5
Suppliers credit sales to turnover ratio

Proportion of Credit Sales to Turnover	Number of Materials Suppliers	Cumulative Number of Materials Suppliers
30.1 – 40%	4	4
40.1 – 50%	4	8
50.1 – 60%	6	14
60.1 – 70%	6	20
70.1 – 80%	12	32
80.1 – 90%	17	49
90.1 – 100%	3	52
TOTAL	*52*	*52*

Mean proportion of suppliers' credit sales to turnover = 70.77%
Median proportion of suppliers' credit sales to turnover = 70.1 – 80%
Mode proportion of suppliers' credit sales to turnover = 80.1 – 90%
Standard deviation = 17.30%
Kolomogorov-Smirnov statistic = 1.53 (0.02 significance)

The average proportion of suppliers' credit sales to turnover is just over 70 per cent whilst the median and mode for the same are slightly higher (70.1- 80 per cent respectively). The standard deviation, when considered in conjunction with the other observations for suppliers' proportion of credit sales to turnover already mentioned, indicates that the sample is negatively skewed. That is, more responses in the 'larger' credit sales to turnover categories than compared to the 'smaller' categories. The Kolomogorov-Smirnov statistic 1.53 (0.02 significance) shows that normality was not present from responses received.

7.4.5 Analysing contractors' creditworthiness

Eighty per cent of suppliers always checked a contractor's creditworthiness before offering them credit. Reasons cited for conducting this check on a '*sometimes*' basis were varied; examples being:

> *'Only if the credit amount requested is in excess of one thousand pounds'*;
>
> *'only if the organisation is unknown to the supplier'*; and
>
> *'only if 'deemed' necessary (e.g. for new companies not having a previous credit track record) '*

Surprisingly, two suppliers with turnover > £25m only carried out creditworthiness evaluation on a *'sometimes'* basis. Interestingly, no suppliers admitted to *'never'* carrying out creditworthiness evaluations for potential debtors (Table 7.6).

Table 7.6
Suppliers' analysis of contractors' creditworthiness

Contractor Creditworthiness Evaluated?	Number of Materials Suppliers	Cumulative Number of Materials Suppliers
Yes, always check contractors' creditworthiness	44	44
Sometimes check contractors' creditworthiness	9	53
Never check contractors' creditworthiness	0	53
TOTAL	*53*	*53*

7.4.6 Credit limit imposition

Just in excess of two thirds of respondents imposed credit limits on > 80 per cent of 'creditworthy' contractors (Table 7.7). Suppliers imposing credit limits on < 20 per cent of contractor clients tended to be 'smaller' organisations with turnovers ≤ £2m per annum.

Table 7.7
Suppliers' credit limit imposed onto creditworthy contractors

Credit Limits Imposed on Contractors (% of total serviced)	Number of Responses	Percentage of Responses	Cumulative Percentage of Responses
1 – 20%	7	13.21	13.21
20.1 – 40%	0	0.00	13.21
40.1 – 60%	3	5.66	18.87
60.1 – 80%	7	13.21	32.08
80.1 – 100%	36	67.92	100.00
TOTAL	*53*	*100.00*	*100.00*

Mean percentage of contractors who have credit limits imposed on them by suppliers = 74.53%
Median proportion of suppliers' credit sales to turnover = 80.1 to 100%
Mode proportion of suppliers' credit sales to turnover = 80.1 to 100%
Standard deviation = 27.64%
Kolomogorov-Smirnov statistic = 2.85 (0.00 significance)

Suppliers tended to impose a credit limit on an average of nearly three-quarters of creditworthy contractors. In the majority of cases, suppliers aimed to retain their credit risk exposure level within an allowable threshold by determining credit limits for 80.1 to 100 per cent of creditworthy contractors. Statistics relating to the standard deviation and Kolomogorov-Smirnov statistic show that the respective responses were widely spread and do not portray normal distribution characteristics.

7.4.7 Credit limit evaluation

Credit registers, Bank references and the duration of (contractor / supplier) relationship were the most common methods of determining credit limits (Table 7.8). Duration of trading relationship was used to an equal extent as Credit registers. Bank references were used by suppliers in 20 per cent of cases. These results highlight that information from Credit registers and Banks (in isolation) is perceived as inadequate for decisions regarding credit quantum.

Table 7.8
Suppliers methods of establishing credit limits for contractors

Methods of Establishing Credit Limits	Number of Responses	Average Percentage of Users	Cumulative Percentage of Users
Credit registers	27	40.30	40.30
Bank information	14	20.90	61.20
Duration of relationship between organisations	26	38.81	100.00
TOTAL	*67*	*100.00*	*100.00*

Number of contributing suppliers = 55. Responses = 67 because some suppliers used more than one method

Previous (business) experience with and working knowledge of, a potential debtor are evidently key elements in creditworthiness assessment. The longer two businesses interact, then the greater their working knowledge of each other (Sako, 1992; Jarillo, 1995). Present credit evaluation models fail to formally account for this. If creditworthiness evaluation procedures could quantify creditor / debtor relationships, this would undoubtedly help in assessing creditor risk more accurately; this is a potential area for future research.

7.4.8 Creditworthiness procedures

Specific contractor creditworthiness evaluation procedures used by suppliers were numerous in nature (Table 7.9) with some unexpected results. For instance, trade references were often used, but suppliers perceived their accuracy as being no greater than 'average'. Similarly, Bankers' references were perceived by suppliers as having a 'poor' degree of accuracy. One would presume that Banking institutions have sound knowledge of their clients and would be able accurately pass this knowledge on to suppliers desiring such information. However, the more finances a Bank can 'arrange' from 'other' sources, then the less a contractor will need to borrow from its Bank, so a transfer of risk is achieved (this situation therefore may have introduced bias into this result). This highlights that for accurate creditworthiness evaluation to be achieved, there is a need for independence between the organisations involved; thereby encouraging objective information.

Table 7.9
Source and methods used of evaluating creditworthiness and perceived accuracy

Source / Method	Number of Users	Percentage of Users	Overall Source Ranked Accuracy	Perceived Accuracy		
				Poor	Average	Good
Bankers reference	29	13.56	4	19	10	0
Contact with company concerned	26	12.15	5	5	16	5
Credit registers	38	17.76	2	3	18	17
Report from salesman	31	14.49	3	3	21	7
Ratio analysis	8	3.74	7=	2	4	2
Trade reference	47	21.96	1	1	30	16
Trade protection association	13	6.07	6	1	7	5
Other	22	10.28	7=		Not applicable	

Altman's Z score (1983) and ZETA model (1993) were presented in the questionnaire, but no respondents (suppliers) used these. Respondent comments regarding Altman's models included:

> *'never heard of this'*

whilst two organisations questioned what ratio analysis was! The former is somewhat understandable and may represent an inability of academia to disseminate its work to practitioners. The latter however is unforgivable! – Every supplier should have a basic understanding of ratio analysis as a means of interpreting contractors' accounts.

Fifty per cent of suppliers indicated that on average, they used four or more different methods for evaluating contractors' creditworthiness. 'Other' methods used for creditworthiness evaluation were 'local information about the contractor' (15.38 per cent users), 'judgement and knowledge of contractors' ability to repay debts' (15.38 per cent users), whilst 11.54 per cent of respondents sought opinion from other suppliers.

7.4.9 Resources used for creditworthiness analysis

The majority of respondents (79.63 per cent) spend no longer than one hour and a mean weighted cost of £46.93 per contractor evaluated (Table 7.10) (the weighting for this calculation was derived from the mean value of the response categories in Table 7.10). The reported cost of credit control departments, represented less than 0.5 per cent of respondents' turnover, for half of the sample. Departments costing between 0.51 and 1 per cent of turnover represented almost 40 per cent of the sample.

Table 7.10
Resources consumed evaluating each contractor's creditworthiness and credit control department costs expressed in terms of percentage turnover per annum

Time Consumed	Number of Responses	Percentage of Responses	Cumulative Percentage of Responses
0 – 1 hour	43	79.63	79.63
1.01 – 3 hours	8	14.81	94.44
3.01 – 6 hours	2	3.70	98.14
6.01 – 12 hours	0	0.00	98.14
Over 12.01 hours	1	1.85	100.00
TOTAL	*54*	*100.00*	*100.00*

Mean time spent evaluating each contractor's creditworthiness = 1.08 hours
Median time spent evaluating each contractor's creditworthiness = 0-1 hour
Mode time spent evaluating each contractor's creditworthiness = 0-1 hour
Standard deviation = 1.76 hours
Kolomogorov-Smirnov statistic = 3.13 (0.00 significance)

Finances Consumed	Number of Responses	Percentage of Responses	Cumulative Percentage of Responses
Under £20	24	44.44	44.44
£21- £50	23	42.59	87.03
£51 - £100	3	5.56	92.59
£101- £200	1	1.85	94.44
£201 - £400	1	1.85	96.29
Over £400	2	3.70	100.00
TOTAL	*54*	*100.00*	*100.00*

Mean finances spent evaluating each contractor's creditworthiness = £46.93
Median finances spent evaluating each contractor's creditworthiness = £21-50
Mode finances spent evaluating each contractor's creditworthiness = under £20
Standard deviation = £82.68
Kolomogorov-Smirnov statistic = 3.13 (0.00 significance)

Cost of Credit Department in Relation to Turnover	Number of Responses	Percentage of Responses	Cumulative Percentage of Responses
Under 0.5%	13	50.00	50.00
0.51 – 1%	10	38.46	88.46
1.01 – 2%	1	3.85	92.31
2.01 – 3%	1	3.85	96.16
3.01 – 4%	1	3.85	100.00
TOTAL	*26*	*100.00*	*100.00*

Mean cost of suppliers' credit control department = 0.70%
Median cost of suppliers' credit control department = under 0.5%
Mode cost of suppliers' credit control department = under 0.5%
Standard deviation = 0.52%
Kolomogorov-Smirnov statistic = 2.99 (0.00 significance)

Figures associated with the time and finances that are involved in evaluating each contractor's creditworthiness, and the cost of suppliers' credit control departments are all positively skewed. This identifies that the majority of suppliers would assign 'little' resources to evaluating contractors' creditworthiness and running of their (supplier) credit control department.

7.4.10 Terms of payment

Sixty eight per cent of respondents allowed contractors credit until the end of the month after delivery of materials supplied. Twenty three per cent of suppliers offered thirty days credit (Table 7.11). Only one supplier offered sixty-day accounts to 'certain' contractors (criteria for this facility not explained). The majority of suppliers (62.26 per cent) did not offer discounts. Of respondents who did, 95 per cent of suppliers give 2½ per cent discount for settlement by the end of the month. One supplier offered 5 per cent discount for payment received by the fifteenth day of the month.

Table 7.11
Supplier standard terms of payment and discounts for prompt payment

Terms Offered	Number of Responses	Percentage of Responses
Thirty days	12	22.64
End of month after delivery	36	67.92
End of month of delivery	5	9.43
Other	see comments	
TOTAL	*53*	*100.00*

Discounts Offered for Prompt Payment	Number of Responses	Percentage of Responses
Yes	20	37.74
No	33	62.26
TOTAL	*53*	*100.00*

The ramifications of the observations relating to suppliers' standard terms of payment and any discounts that are offered contractors, insinuate that contractors should not only consider the quoted price of materials. Contractors who are granted credit by a supplier should consider the terms of credit offered by the supplier and any discounts that may be available for prompt payment.

7.4.11 Suppliers' Financial Characteristics

The majority of respondents (79.63 per cent) incurred less than 1 per cent (of turnover) bad debt, in financial year 1997-8 (Table 7.12). Fifteen per cent of suppliers admitted to bad debt accounting for between 1.01 and 2 per cent of turnover. Of those suppliers whose bad debt exceeded 1 per cent, the estimated cumulative total approaches £1m. This figure was obtained by multiplying suppliers' percentage bad debt by their turnover.

Table 7.12
Bad debt encountered in previous financial year (1997-8)

Bad Debt to Sales	Number of Responses	Percentage of Responses	Cumulative Percentage of Responses
Under 1%	43	79.63	79.63
1.01 and under 2%	8	14.81	94.44
2.01 and under 3%	2	3.70	98.14
3.01 and under 4%	0	0.00	98.14
4.01 and under 5%	0	0.00	98.14
5.01% and over	1	1.85	100.00
TOTAL	*54*	*100.00*	*100.00*

Mean bad debt to sales = 0.81%
Median bad debt to sales = under 1%
Mode bad debt to sales = under 1%
Standard deviation = 0.77%
Kolomogorov-Smirnov statistic = 3.32 (0.00 significance)

Suppliers' mean percentage of bad debt incurred was estimated at 0.81 per cent on credit sales turnover. The standard deviation (0.77 per cent bad debt incurred) combined with the mean bad debt figure indicates that the sample was positively skewed. As with previous response data, normality was not present when considering the respective responses and bad debt implications.

7.4.12 Suppliers' targeted profit margin

Observation of the profit margin sought before bad debt is encountered, yields a spread of answers (Table 7.13). Mean profit margin was 8.57 per cent.

Table 7.13
Suppliers' targeted profit margin before bad debt is taken into account

Targeted Profit Margin Before Bad Debt Implications	Number of Responses	Percentage of Responses	Cumulative Percentage of Responses
Under 2%	4	8.51	8.51
2.01 – 4%	7	14.89	23.40
4.01 – 6%	9	19.15	42.55
6.01 – 8%	4	8.51	51.06
8.01 – 10%	4	8.51	59.57
10.01 – 12.50%	4	8.51	68.08
12.51 – 15.00%	0	0.00	68.08
15.01% and over	15	31.91	100.00
TOTAL	*47*	*100.00*	*100.00*

Mean targeted profit margin before bad debt considered = 8.57%
Median targeted profit margin before bad debt considered = 6.01–8%
Mode targeted profit margin before bad debt considered = 15.01% and over
Standard deviation = 5.18%
Kolomogorov-Smirnov statistic = 1.45 (0.03 significance)

Statistics relating to the mean and standard deviation of the targeted profit margin before bad debt is considered, indicates that the population was slightly positively skewed, though normality in the data could not be assumed. Responses indicated that suppliers either tended to aim for 'very good profit margins' (i.e. 15.01 per cent and over) or profit margins of six per cent or less. Future research into the characteristics that determine suppliers' targeted profit margins may be useful, as this would indicate to contractors which suppliers to interact with if the lowest priced materials are being sought. However, this assumption assumes that suppliers will have identical overheads; which is a simplified view and cannot be correct. Future analysis could investigate factors relating to the total cost of given materials.

7.4.13 Collection of overdue accounts

Debt collection is intrinsic to credit control; this is because efficient collection offsets bad debts. The majority of respondents (92.59 per cent) have a standard procedure for collecting overdue accounts. Those suppliers who did not, stated that their debt collection procedures were dependent upon the particular contractor owing the debt. The contractor in this sense was defined as either being known to the supplier, and / or dependent upon the amount of money owed. However, definitions of what suppliers meant by 'knowing' a contractor, or the quantity of debt necessary, was undefined. Future research could identify if contractors owing debts to a supplier who does have a standard debt collection procedure in place, realise this and hence leave payment until the last possible instance? The opposing side to this investigation would be that varying suppliers' debt collection procedures may imply to debting contractors that there is an urgency associated with making the repayment?

Analysis indicated that reminder letters were the most common option of debt collection. Contractors' response to these letters tended to be 'average' (Table 7.14). Two respondents identified trade protection associations as the 'optimal' solution for collecting debts. Visits, by a supplier's credit department to contractors who owed debts were cited an effective method of collection – maybe the 'physical' presence of a 'debt collector' has greater coercive power than letters or telephone calls? More 'formal' collection methods (summons and / or court action) seemed to offer a response not greater than 'average'. Perhaps it is because at this stage (time duration of outstanding debt), contractors' debts may have escalated to such an extent as to render them too great for the contractor to ever repay? Again, only future research could definitively answer this question.

Table 7.14
Debt collection procedures

Standard Procedure for Collection of Overdue Accounts	Number of Responses	Percentage of Responses
Yes	50	92.59
No	4	7.41
TOTAL	*54*	*100.00*

Procedure Used	Number of Suppliers Taking Action	Average Number of Times Used Per Year	After How Many Days Overdue (Average)	Debtor's Response (Average)		
				Good	Average	Poor
Further statements	25	450.00	10.60	2 (9.52)	16 (76.19)	3 (14.29)
Reminding letter	47	1405.00	16.74	17 (40.48)	24 (57.14)	1 (2.38)
Contact by salesman	28	209.00	14.86	13 (50.00)	11 (42.31)	2 (7.69)
Telephoned by credit department	42	567.00	18.17	26 (63.42)	14 (34.15)	1 (2.43)
Visited by credit department	9	29.00	26.00	5 (71.43)	2 (28.57)	0 (0.00)
Account taken to collection agency	17	48.00	27.11	8 (50.00)	6 (37.50)	2 (12.50)
Trade protection association intervention	2	2.50	30.00	2 (100.00)	0 (0.00)	0 (0.00)
Summons issued by credit section	15	16.47	41.47	9 (69.23)	3 (23.08)	1 (7.69)
Summons issued by legal department	6	21.00	38.17	2 (50.00)	2 (50.00)	0 (0.00)
Summons issued by solicitor	30	12.80	44.13	12 (46.15)	10 (38.46)	4 (15.38)
Court action	30	6.43	51.07	13 (46.43)	9 (32.14)	6 (21.43)

Figures in parenthesis indicate percentage observations

7.4.14 Insurance and factoring

Very few respondents insured against bad debt. This finding contrasts with Agapiou, et al.'s (1998b) paper. Of those suppliers who did insure against bad debt, the type of insurance policy most often used was a whole turnover policy[1]. Turnover policies used by suppliers varied in the percentage of debt that they could claim for (Table 7.15). Evidently therefore, many respondents are directly exposing themselves, without any financial backing other than their own organisation's assets, to possible bad debts. Only one supplier used factoring. This finding highlights the importance of suppliers using accurate contractor creditworthiness evaluation and quality debt collection procedures. This observation goes some way to justify the importance of the research reported in this thesis.

7.4.15 Acceptable bad debt

The amount of bad debt considered 'acceptable' was below 1 per cent of turnover for the majority of respondents (75.47 per cent) (Table 7.16). Twelve suppliers stated that bad debt could amount to between 1 and 2 per cent of turnover.

Statistics relating to the mean and standard deviation (that is associated with suppliers' acceptable bad debt) indicate that the responses were positively skewed. This means that the majority of suppliers incurred less bad debt than the mean figure. It is reiterated at this point that the survey was undertaken at a time of general economic growth and that this may have influenced results associated with suppliers amount of bad debt incurred. The Kolomogorov-Smirnov statistic derived from responses to 'acceptable' bad debt indicate that the distribution is not normal.

[1] *A whole turnover policy is where the credit insurance company allows suppliers to grant credit to contractors without first consulting the insurance company.*

Table 7.15
Insurance and factoring against bad debt statistics

Insurance Against Bad Debt	Number of Responses	Percentage of Responses
Yes	6	11.11
No	48	88.89
TOTAL	*54*	*100.00*

If insurance policy used

Type of Policy	Number of Responses	Percentage of Responses
Specific debt	1	16.67
Whole turnover policy	5	83.33
TOTAL	*6*	*100.00*

If whole turnover policy used, percentage of bad debt insured against

Type of Policy	Number of Responses	Percentage of Responses
Under 75%	1	20.00
75.1 – 85%	1	20.00
85.1 – 95%	2	40.00
95.1 – 100%	1	20.00
TOTAL	*5*	*100.00*

Factor Against Bad Debt	Number of Responses	Percentage of Responses
Yes	1	1.85
No	53	98.15
TOTAL	*54*	*100.00*

If Factor policy used

Type of Policy	Number of Responses	Percentage of Responses
Under 75%	0	0.00
75.1 – 85%	1	100.00
85.1 – 95%	0	0.00
95.1 – 100%	0	0.00
TOTAL	*1*	*100.00*

Table 7.16
Acceptable bad debt on credit sales

Acceptable Bad Debt	Number of Responses	Percentage of Responses	Cumulative Percentage of Responses
Under 1%	40	75.47	75.47
1.01 – 2%	12	22.64	98.11
2.01 – 4%	1	1.89	100.00
TOTAL	*53*	*100.00*	*100.00*

Mean acceptable bad debt on credit sales = 0.79%
Median acceptable bad debt on credit sales = under 1%
Mode acceptable bad debt on credit sales = under 1%
Standard deviation = 0.53%
Kolomogorov-Smirnov statistic = 3.24 (0.00 significance)

7.4.16 Creditworthiness reassessment

Over 85 per cent of respondents reassess contractor creditworthiness cyclically; though the time duration for carrying out such a reassessment tended to vary greatly. Only 10 per cent of respondents stated that they would reassess contractors if the economy was in recession, in addition to the re-evaluation regime they already operated (Table 7.17).

Surprisingly, one organisation with a turnover greater than £25m per year, and another that supplies materials to contractors nation-wide, did not reassess creditworthiness at all. Many suppliers (56.36 per cent) reassess credit risk on an '*if and when the need arises*' basis **only**. No standard time period between suppliers carrying out contractor creditworthiness reassessment intervals was identified. The majority of suppliers reassessed when changes in contractors' characteristics (such as slowing down of payments, an increase in contractor turnover and / or a contractor coming under the control of new management) occurred.

Twenty-two respondents who did not reassess in times of recession and only on an *'if and when the need arises'* basis, all considered changes in contractor characteristics as sufficiently important carry out a reassessment of a potential debtor's creditworthiness.

Table 7.17
Creditworthiness reassessment policy, guarantees for substantial order and present creditworthiness evaluation procedures acceptability

Contractors' Creditworthiness Reassessed	Number of Responses	Percentage of Responses	Cumulative Percentage of Responses
Yes	47	87.03	87.03
No	7	12.93	100.00
TOTAL	*54*	*100.00*	*100.00*

Reassessment Intervals	Number of Responses	Percentage of Responses	Cumulative Percentage of Responses
Weekly	2	3.33	3.33
Monthly	1	1.67	5.00
Quarterly	2	3.33	8.33
Half Yearly	5	8.33	16.66
Yearly	10	16.67	33.33
If and when the need arises	40	66.67	100.00
TOTAL	*60*	*100.00*	*100.00*

Reason for Reassessment	Number of Responses	Percentage of Responses	Cumulative Percentage of Responses
Payments slowed down	46	30.67	30.67
Contractor's turnover increased dramatically	49	32.67	63.34
Contractor under new management	39	26.00	89.34
Economy in recession	16	10.67	100.00
TOTAL	*150*	*100.00*	*100.00*

Substantial Order Placed; Guarantee Asked For	Number of Responses	Percentage of Responses	Cumulative Percentage of Responses
Yes	10	18.52	18.52
No	14	25.93	44.15
Sometimes	30	55.56	100.00
TOTAL	*54*	*100.00*	*100.00*

Table 7.17 shows that > 25 per cent of respondents would not ask for guarantees of payment if a contractor placed a 'substantial' order. Reasons for this were not stated, but it does suggest that suppliers who conduct their business without giving consideration to the amount of potential debt that they are exposing themselves to, are failing to fully appreciate the increased financial risk associated with such business interaction. Future research could investigate what influences different levels of financial risk exposure impose upon suppliers.

7.4.17 Correlation analysis of survey data

Having considered responses in isolation, correlation analysis was used to observe association among the survey response data. Spearman's rho correlation analysis (r_s) was used because it has the ability to deal with non-normal data. Spearman's rho is unable to cope with qualitative data, so only quantitative survey responses were considered in this section of analysis. The mathematical formula to derive a Spearman's rho correlation for investigating the association between two variables is:

$$r_s = 1 - \frac{6\sum(R_X - R_Y)^2}{n(n^2 - 1)} \qquad \text{(Formula 7.2)}$$

Where: r_s = Spearman's rho correlation; R_X = ranking associated with variable X; R_Y = ranking associated with variable Y; and n = the number of paired values (Oltman and Lackritz, 1991 pp.901-2).

When r_s = 1, then this indicates that there is perfect positive correlation between the variables being considered i.e. an increase in one variable indicates an increase in the 'other' variable being considered. Conversely, when r_s = -1 then perfect negative correlation exists. Having presented the mathematical formula for deriving correlation coefficients, a correlation matrix was derived from responses to the survey data (from suppliers' credit control and debt collection procedures) using SPSS software (Table 7.18). The 'coding' procedure used in the Table is based on the question numbers in the survey. The suffix of 'O' denotes that the question was ordinally categorized data. It is pointed out here that correlation analysis identifies association, but not necessarily 'causation'.

Table 7.18
Spearman's rho correlations

	Q12O	Q13O	Q16O	Q17O	Q21O	Q3O	Q5O	Q6O	Q8O
Q11O	0.44**	0.04	-0.05	-0.08	-0.21	0.13	0.20	0.08	0.17
Q12O	1.00	-0.20	-0.19	-0.11	0.03	0.40**	0.34*	0.31*	0.30*
Q13O		1.00	0.04	0.19	0.14	-0.13	-0.06	-0.29*	0.01
Q16O			1.00	0.03	0.42**	-0.09	-0.05	-0.20	-0.33*
Q17O				1.00	0.08	0.13	0.08	-0.20	-0.02
Q21O					1.00	-0.09	0.06	-0.15	-0.11
Q3O						1.00	0.83**	0.47**	0.56**
Q5O							1.00	0.41**	0.49**
Q6O								1.00	0.31*
Q8O									1.00

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2 tailed).

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Q11O time duration spent evaluating each contractor's creditworthiness
Q12O finances spent evaluating each contractor's creditworthiness
Q13O cost of each suppliers' credit control department
Q16O percentage of bad debt to sales in last financial year (1997-98)
Q17O percentage profit margin aimed for
Q21O maximum percentage of 'acceptable' bad debt
Q3O annual financial turnover of each supplier
Q5O number of credit accounts each supplier had in last financial year
Q6O suppliers' proportion of total sales accounted for by credit furnished
Q8O proportion of contractors offered credit that have credit limits imposed upon them

Evaluation of time (Q11O) and cost (Q12O) restraints have a significantly high level of correlation ($r_s = 0.44$, $P \leq 0.01$). It is interesting to note that time restraint is not correlated with any other variables. This possibly suggests that suppliers place greater faith in an 'outside' organisation defining creditworthiness compared to carrying out assessment in-house. The restraint for money involved in creditworthiness evaluation (Q12O) is positively correlated with the financial turnover of suppliers – the more money spent on evaluating individual contractor's creditworthiness – then the greater the suppliers' financial turnover (Q3O) tends to be (by association only). This would imply that smaller financial turnover suppliers tend to spend less money on evaluating a potential debtor than do larger turnover suppliers. Maybe it is the case that smaller turnover suppliers tend to 'know' the contractors they trade with and can thereby make judgements about their creditworthiness based on this relationship?

The number of contractor trading accounts that have credit limits imposed upon them by suppliers (Q8O) is positively correlated with the volume of finances spent evaluating individual potential debtors' creditworthiness (Q12O). Combined with the positive correlation of the quantity of sales achieved using credit (Q6O), this possibly indicates that when suppliers pay for a creditworthiness check, they also received information about a credit limit for that organisation, which in turn, is implemented?

Also positively correlated with finances spent evaluating individual potential debtors' creditworthiness (Q12O) are the number of credit accounts furnished (Q5O). Combined with the previous observations, maybe suppliers with large percentages of credit sales realise the importance of 'correctly' classifying potential debtors' creditworthiness? Subsequently, they may be more willing to spend resources on this task to ensure 'accurate' evaluation.

The cost of credit control departments (Q13O) is negatively correlated with the proportion of suppliers' sales accounted for by contractors furnished credit (Q6O). Hence, as the proportion of suppliers' credit sales increases there is a converse reduction in suppliers' credit control department costs. This follows the economic theory of *economies of scale*. That is, the cost of a single item decreases as the quantity of the item being produced / evaluated increases.

The quantity of bad debt encountered by suppliers in the last financial year (1997-8) (Q16O) is positively correlated with suppliers' amount of bad debt regarded as 'acceptable' (Q21O). This would indicate that suppliers are not unduly concerned with the accuracy of their present contractor creditworthiness evaluation methods and / or the efficiency of their debt collection procedures employed. Any supplier who can reduce the amount of bad debt they incur is directly influencing potential profit margins and indirectly gaining a competitive advantage (this assumes all other factors remain constant). Further, this correlation observation insinuates that as the quantity of debt increases, so suppliers' acceptance of debt becomes more acceptable! This is unexpected, but the correlation statistics for bad debt encountered and 'acceptable bad debt' reinforce previous research. That is, it is difficult to be critical of one's own working practices (see Handy, 1993 p.342).

The percentage of contractors who have credit limits imposed upon them by materials suppliers (Q8O) exhibit a negative correlation with the quantity of bad debt that the supplier encountered in financial year 1997-8 (Q16O). This association shows that as a supplier's percentage of credit limits imposed onto contractors increases, there is a subsequent reduction in the amount of bad debt incurred. It has been found that the greater the amount of credit allowed by a creditor, results in a hyperbolic loss in the utility value of the furnished credit (Chapter 5). This points towards allowing contractors minimal credit. However, this contradicts that to retain profit *quantities,* profit *margins* have to be increased. Thus, a balance has to be observed by each supplier (between the supplier's credit risk exposure level and factors that impact upon this) to ensure that the amount of credit furnished is not having a prejudicial effect on their utility, whilst still retaining their degree of competitiveness.

Suppliers' financial turnover (Q3O) is positively correlated with: the number of credit accounts (Q5O); proportion of sales accounted for by credit (Q6O); and proportion of contractors that credit limits are imposed upon (Q8O). All other permutations of these three variables are also positively correlated. These results are logical, because 'larger' turnover suppliers will (it is generalized) have to interact with a greater number of contractors than compared to 'smaller' turnover suppliers. Similarly, because of having to interact with such a number of contractors, it is envisaged that 'personal' knowledge of potential debtors is forgone. In turn, this means that suppliers impose credit limits onto these contractors, so that the risk associated with granting them credit, is kept within an allowable risk threshold.

Having presented a number of initial findings from the data analysis, the next section in this chapter details future research that could be conducted. The underlying reason for including this section here is that it reinforces the novelty of this research. That is, there has been very little work conducted that concentrates specifically upon defining the risk that creditors expose themselves to when they furnish contractors with credit.

7.5 INTERIM FINDINGS: SUPPLIERS' CREDIT RISK

Evidently, materials supply was a growing industry sector during the period under investigation (1995-1998). Average supplier turnover growth from financial year 1995 to 1998 was 5.85 per cent. When considered in tandem with suppliers' targeted profit margins, there is further evidence that suppliers are operating in a profitable industry sector. Because of this, it begs the question: *'what would be the result of suppliers offering higher 'risk' contractors credit facilities?'* By exposing themselves to greater financial risk by granting higher risk contractors credit, suppliers' turnover would increase but there would be greater probability of incurring bad debt. Presently, creditworthiness evaluation procedures do not incorporate a 'degree of creditworthiness' measure – potential debtors are either defined creditworthy, or not. Since a balance should be present between the amount of credit offered and associated risk, research is required in this domain.

Resources available for evaluating contractors' creditworthiness are finite. Any model proffered for improved creditworthiness evaluation should operate within such constraints if mass usage is to be achieved. Although the survey identified substantial time and money constraints imposed onto suppliers' credit control and debt collection departments, it could be the case that an 'accurate' creditworthiness evaluation procedure may need to consume greater resources than those at present. This is because information costs money: additional resources consumed need to be counteracted with an increase in evaluation accuracy i.e. value for money (see Holt, et al., 1994 p.139).

Respondents incurred a small percentage of bad debt in their last (reported) financial year (1997-1998), so this result may be perceived as somewhat reducing the need for further research in the domain of contractor creditworthiness evaluation and subsequent debt collection. However, the caveats detailed at the beginning of this chapter concerning the economic climate are reiterated. It is hypothesised that bad debt encountered by suppliers in a period of recession increases; identifying the need for creditworthiness models to consider the economic environment on a macro scale. This prompts the question: *'what would be the effects of a period of recession on the amount of bad debt that materials suppliers may encounter?'*

Obviously, this is not a definitive list of future research that could be conducted in this specific subject domain. However, what the above questions do continue to highlight is the vast amount of future research that could be conducted into the risk that suppliers expose themselves to, when they furnish contractors with credit.

7.6 SUMMARY

Pertinent issues regarding suppliers' tendencies, preferences and traits associated with contractor creditworthiness evaluation and debt collection procedures, have been raised. Key findings of the survey were:

- Supplying materials to the construction industry is potentially profitable.
- Credit sales account for a large proportion of materials sold to the construction industry (mean = 70.77 per cent).
- Credit limits are highly dependent upon the duration of the historical relationship between the materials supplier and contractor.
- Suppliers use a number of sources and methods for evaluating the creditworthiness of contractors.
- Suppliers' resources used in evaluating contractors' creditworthiness are highly restrained both in time and finances.
- Very few suppliers offer discounts for prompt payment.
- Insurance and factoring of debts is used only by a minority of suppliers.
- Reassessment of creditworthiness is carried out in the majority of cases on an *'if and when the need arises'* basis.

These findings, of the first reported investigation into methods used by construction materials suppliers to evaluate construction contractor creditworthiness, provide evidence that there is a need this research. Many of the findings of the survey highlight that credit risk is an amalgam of analysing previous credit records as well as incorporating a degree of good luck and judgement by the crediting organisation. Future research could remove the luck element from this equation, and replace it with accurate quantifiable procedure(s). The overall conclusion of the chapter is that analysis of credit risk presently embraces an amount of 'luck' and 'judgement' on the part of creditors.

Having now gathered information relating to suppliers' employed evaluation practices, the next chapter utilises this information to model a number of factors that have been identified as having an influence upon suppliers' utility achieved from granting credit. That is, practices of suppliers' credit control and debt collection departments are investigated to identify which practices of these departments influence the utility a supplier achieves from granting a contractor credit i.e. variables identified in chapter 5 (which have an influence on the utility achieved by a supplier from granting a contractor credit) are investigated in greater depth.

CHAPTER 8

MODELLING SUPPLIERS' CHARACTERISTICS: FINANCIAL TURNOVER; TURNOVER MOVEMENT; PROFIT; AND BAD DEBT

8.1 INTRODUCTION

This penultimate chapter of the thesis models a number of suppliers' credit control and debt collection characteristics to forecast:

- suppliers' financial turnover;
- suppliers' financial turnover movement over three financial years (1995-1998);
- suppliers' targeted profit margin; and
- the amount of bad debt incurred by suppliers in financial year 1997-8.

The reasons for investigating these four characteristics are that:

- Further insight is gained into generic elements *D* (the efficiency of suppliers' debt collection procedures and amount of credit allowed contractors) and *Cr* (the degree of creditworthiness in the supplier / contractor relationship) of the conceptual model detailed in Chapter 3 (Formula 3.3).

- Suppliers are so important to the UK construction industry that any research able to identify key factors in assisting their survival, has to be embraced.
- Because suppliers operate in a competitive market place, variables associated with their credit control and debt collection procedures (i.e. that influence their competitiveness) need to be known.
- The factors under specific investigation (supplier turnover; turnover movement; profit margin; and bad debt incurred) have all been shown to impact upon the utility experienced by a supplier, when furnishing credit to a contractor.

The majority of this chapter was published in Nicholas, et al. (2000c; 2000g; 2000h and 2000i).

Having set the 'wider scene', the structure of the chapter is now detailed.

8.1.1 Chapter structure

This chapter consists of seven main sections. These being:

- Section 1 introduces the chapter and its contents.
- Section 2 details MDA concepts and applications.
- Sections 3 to 6 describe four MDA models.
- Section 7 contains conclusions obtained from the MDA analyses.

Following the introduction to the chapter in the first section, the second section provides a description of the MDA statistical technique that is used to discriminate between different groups of the dependent variables (i.e. suppliers' turnover;

turnover movement; profit; and bad debt). Then, the following four sections consist of multi-variative discriminate analysis (MDA) models that forecast: i) suppliers' financial turnover; ii) suppliers' financial turnover movement over three financial years (1995-1998); iii) suppliers' targeted profit margin; and iv) the amount of bad debt incurred by suppliers in financial year 1997-8. The seventh and final section concludes the chapter, with observations and findings that have arisen from the MDA analyses presented.

8.2 STATISTICAL ANALYSIS METHOD EMPLOYED

Multivariate discriminant analysis (MDA) was used for the task of identifying differences between different groups of dependent variables. This is because MDA allows one to:

> *'study differences between two or more groups of objects, with respect to several variables simultaneously'* (Klecka, 1987 p.7).

Other statistical techniques were considered for classifying the dependent variables, such as multiple regression and correlation analysis. However, MDA was selected in favour of these techniques because it provided statistically significant results in the context that was desired. This is something that the 'other' techniques failed to achieve. The reason for MDA's 'success' in this setting was mainly because of its ability to deal with multivariate data and identify key factors being associated with the dependent variable under consideration.

To identify statistically significant discriminating variables, stepwise MDA was performed using SPSS software. Stepwise MDA was chosen as the method to include, or exclude variables, because it selects only the most powerful discriminators. Klecka (1987 p.52) reinforces this approach and adds that stepwise MDA is useful for removing variables that do not contribute statistically, towards improving the overall accuracy of a MDA model. 'Forward' and 'backward' stepwise procedures were used simultaneously. There are some that reject the usefulness of stepwise MDA, on the basis that in the 'real world' *all* variables impact upon an outcome to some extent. However, for an exploratory analysis such as this, it is the *significant* variables that one is interested in, and stepwise MDA has the ability to highlight these effectively.

The procedure of stepwise MDA involves first selecting a preliminary independent variable (i.e. with the largest discriminating power). The value of the acceptance / rejection criteria is then re-evaluated for all remaining variables, and the (remaining) variable with the largest discriminating power is then added to the MDA model. The variable entered first is then re-evaluated to determine if it meets the removal criteria. If the variable does, it is removed. The procedure then starts this process again, until all independent variables have either been accepted or rejected (Norušis, 1985 p.93). The criteria for inclusion or exclusion of variables for the MDA model used in this research, were set at a probability of the '*F*' statistic being five and ten per cent respectively. The '*F*' statistic refers to potential variables being included in the final MDA analysis being tested to observe if they contribute statistically significantly towards classifying the dependent variable (Klecka, 1987 pp.57-8).

The fundamental concept of MDA is to identify and quantify the linear association between independent variables, thereby classifying them into 'groups' of the dependent variables. MDA can subsequently classify (new) cases into said groups based on the derived MDA functions (models). Linear association is measured via four main statistics:

The eigenvalue: this is the ratio of the between-groups sum of squares, to within-groups sum of squares. 'Good' functions have large eigenvalues. The eigenvalue is calculated from:

$$\lambda = \frac{SSb}{SSw} = \frac{\sum_{g=1}^{k} Ng(\bar{x}_{gi} - \bar{x}_i)(\bar{x}_{gj} - \bar{x}_j)}{\sum_{g=1}^{k}\sum_{n=1}^{Ng}(x_{gin} - \bar{x}_{gi})(\bar{x}_{gjn} - \bar{x}_{gj})} \qquad \text{(Formula 8.1)}$$

Where k = the number of samples of size Ng; $\bar{x}_{gi}$ = the ith element of $\bar{X}_g$; $\bar{x}_i$ = mean of x_i; $\bar{x}_{gj}$ = the jth element of $\bar{X}_g$; and λ = the eigenvalue for the derived MDA function.

Wilks' Lambda: this is the multi-variative measure of group differences over several variables (Klecka, 1987 p.38). When Wilks' Lambda is zero it denotes the group centroids are greatly separated and there are distinct differences between the derived groupings. The formula to derive Wilks' Lambda is:

$$\Lambda = \prod_{i=k+1}^{q} \cdot \frac{1}{1+\lambda_i} \qquad \text{(Formula 8.2)}$$

Where: Λ = Wilks' Lambda; k = the number of functions derived for the MDA in question; λ_i = the value of the eigenvalue for each derived respective function $_i$; $\prod$ = the individual terms are multiplied together to yield the final product of q terms (Klecka, 1987 p.39).

The chi-square statistic: which is the transformation of Wilks' lambda. The chi-square statistic tests the null hypothesis that there is no difference between derived group means. The formula to derive the chi-square statistic for the respective discriminant functions is:

$$\chi^2 = -\left[n. - \left(\frac{p+g}{2}\right) - 1\right] \log_e \Lambda_k \qquad \text{(Formula 8.3)}$$

Where: χ^2 = the obtained chi-squared statistic for the derived MDA function; p = the number of discriminating variables; g = the number of groups / leagues the dependent variable is segregated into; and Λ_k = Wilks' Lambda for $_k$ number of discriminant functions already derived; and n = the total number of cases.

The canonical correlation: this measure considers the utility of the derived discriminant function. The canonical correlation is similar to the Pearson correlation, and details the association between the groups and the discriminant function. The canonical correlation ranges from zero to one; one representing one hundred per cent of the total variance being accounted for by the function. It is calculated from:

$$r_i^* = \sqrt{\frac{\lambda_i}{1+\lambda_i}} \qquad \text{(Formula 8.4)}$$

Where: r_i^* = the canonical correlation for the $_i$ discriminant function; λ_i = the eigenvalue for the $_i$ th discriminant function.

To group a supplier into a particular category of the dependent variable, the following formula is used:

$$D_{kx} = c_1 Y_{1kx} + c_2 Y_{2kx} + c_3 Y_{3kx} + \ . \ . \ . \ + c_n Y_{nkx} \qquad \text{(Formula 8.5)}$$

Where: D_{kx} = the dependent variable; i.e. the discriminant score from the canonical discriminant function for case x in group k; Y_{nkx} = discriminating variable Y_n for case x in group k; and c_n = discriminating coefficients (Klecka, 1987 p.15).

8.2.1 Discriminant analysis assumptions

There are presently two lines of thought regarding the nature of those data that MDA can accurately utilise. Statisticians (e.g. Goldstein and Dillon, 1978; Lachenbruch and Goldstein, 1979; Hand, 1981; Norušis, 1993) insist that the data to be analysed have normal (0,1) characteristics and equal covariances (covariance is an observation involving the relationship between two data sets, in terms of their mean and respective actual observations [Huberty, 1994 p.6]). However, pragmatists (e.g. Klecka, 1987; Manley, 1991), having realised that to obtain such data can have practical limitations, substantiate the method's use by proving the accuracy of any derived MDA model by its application to an additional, independent set of data. This is performed as a means of reviewing the model's predictive ability. However, it is acknowledged (ibid.) that hypothesis testing loses some degree of accuracy when normality and equal covariances are not present in those data analysed. In the context of construction management (and 'other' research domains), discriminant analysis has been extensively used (e.g. Mason and Harris, 1979; Altman, 1983; Taffler, 1983; Skitmore and Marsden, 1988; Russell and Jaselski, 1992; Shash and Abdul-Hadi, 1993; Tam and Harris, 1996). These latter pragmatists tested their models' predictive abilities by applying them to the original 'problem' and / either looking for 'logical' conclusions and the percentages of cases correctly classified. This proven approach to the application and validation of the technique is adopted throughout this chapter.

The data that was to be modelled emanated from a survey of materials suppliers' credit control and debt collection procedures, as detailed in Chapters 6 and 7 of this thesis. Transformations on the survey data were performed (as detailed in Chapter 4) with the aim of achieving normal, or near normal distributions with equal covariances. Unfortunately, transpositions failed to produce such characteristics. When removing those data from analysis that were prejudicing these statistical characteristics (i.e. outliers), the size of the sample was unacceptably reduced. A further attempt was made to segregate suppliers into two groups; i.e. those with characteristics to either the left or right tails of the overall distribution. Transformations that were tried, but failed to produce the required statistical characteristics were removed from future consideration. However, Z-scores were calculated for all response categories using Formula 8.6:

$$Z_i = \frac{X_i - \overline{X}}{S}$$ (Formula 8.6)

Where: X_i denotes the value of observation $_i$; $\overline{X}$ is the mean of distribution X; S is the standard deviation of X's distribution; and Z_i is the Z-score for the $_ith$ variable. While Z-scored data did not produce normality in the data or provide equal covariances, the transformation was used in future analysis because it did provide stepwise MDA another potential avenue of investigation to be taken. That is, stepwise MDA could choose to either accept or reject this additional data when discriminating for the dependent variable.

8.2.2 Survey response coding

To transform survey response categories into a format suitable for MDA, a coding procedure was used. This procedure categorised responses to survey questions nominally, and wherever possible, ordinally.

For distinct identification purposes questionnaire numbers were used, along with a suffix of either 'N' or 'O' depending on the 'type' of data being described (i.e. nominal or ordinal respectively). A prefix of Z denoted a Z-scored variable. For example, question 3 was nominally and Z-score categorised, so it was coded ZQ3N. For readability, only those variables found to be significant in successfully classifying the dependent variables are detailed in this chapter.

8.2.3 Dependent variable 'grouping'

To establish the number of 'leagues' that the dependent variables should be segregated into, Oltman and Lackritz (1991 pp.34-35) suggest:

$2^k \leq N$ (Formula 8.7)

Where: k denotes the number of leagues (classes); and N is the number of observations. There were 55 sets of independent observations in the survey, so five 'leagues' ($2^5 \leq 55$) are recommended. Though Formula 8.7 does provide a definitive number of leagues for segregating data into; the formula is only a recommendation and guide: it has no statistical underpinning. Because of this, some of the MDA presented in this chapter do follow Oltman and Lackritz's recommendation. However, additional MDA presented utilise a different number of leagues for the dependent variable. This is so that the optimal MDA analysis is obtained, in relation to the stratification of survey responses and the subsequent results of the MDA.

8.2.4 MDA model validation

To validate the derived MDA models, the MDA functions were subsequently applied to an independent set of ten suppliers' characteristics. The ten suppliers used for this 'hold-out' sample had characteristics that were suitable for them to be included in the survey sample (detailed in Chapter 6). That is, the ten suppliers being used for the hold out sample had not replied to the original survey, however, when contacted by telephone these suppliers did agree to complete and return the questionnaire. Having applied the respective MDA functions to the 'hold-out' sample, the number of suppliers whose characteristics were correctly classified were noted as a measure of the model's ability. A comparison was then made between the percentage of suppliers who had their characteristics correctly classified (and on which the MDA function was derived), and the 'hold-out' sample. If similarities in classification accuracy were shown, then it was accepted that the MDA function was validated.

Having presented the fundamental mathematical concepts of MDA, the following four main sections of this chapter apply the statistical procedure to model four different supplier characteristics.

8.3 PREDICTING SUPPLIERS' FINANCIAL TURNOVER

Materials suppliers play a very important role within the construction industry supply chain, as evidenced by the research in this thesis. Due to the materials market being essentially monopoly free, suppliers provide contractors with materials at as keen prices as market conditions permit. Because of these facts, healthy financial turnover is requisite to suppliers' ongoing survival. It is this issue of financial turnover that is focussed upon in this section of the chapter.

This section of the chapter does not aim to define what characteristics 'good' materials suppliers exhibit (in comparison to 'bad' suppliers). Instead, it concentrates upon identifying discriminating characteristics between different (financial turnover) size suppliers. Another reason for investigating supplier turnover is because, on a macro level, larger turnover suppliers provide the construction industry with a greater amount of working capital (i.e. furnished credit), than do smaller turnover suppliers (Chapter 7).

The theory of economies of scale reinforce the need for suppliers to achieve the largest turnover that market conditions (and e.g. management skills) allow. In part, this is because large suppliers will be able to better negotiate discounts from their product-manufacturers. This results in large suppliers (potentially) being able to offer materials at a lower price than do smaller suppliers. The long-term result of this is that construction materials costs remain keen. Managerial skill as well as their characteristics also impact upon supplier turnover. This is because managers make the ultimate decision of whether to trade with a certain contractor (or not). Management also make strategic decisions regarding desired turnover growth, targeted profit margins and so forth.

8.3.1 Results of data analysis regarding suppliers' financial turnover

Multivariate discriminant analysis identified that suppliers' turnover could be classified with a significant degree of accuracy, using the following variables:

i. the suppliers' attitude towards insuring themselves against bad debt;
ii. the number of credit accounts furnished;
iii. the percentage of (creditworthy) contractors that have credit limits imposed upon them;
iv. whether guarantees of payment are sought for substantial orders; and
v. the percentage growth or contraction, that a supplier experienced in the last three trading years.

The overall accuracy of the MDA model was 56.4 per cent. Using an independent hold-out-sample of ten suppliers, the derived MDA model correctly classified five out of these ten suppliers. Hence, the robustness of the model was confirmed.

When reviewing the statistics obtained for the MDA model (see Table 8.1), it is evident that the variables and associated coefficients for Function 1 discriminate better than any of the other functions. This statement is based on the knowledge that 'large' eigenvalues have better discriminating power than 'small' eigenvalues (Klecka, 1987 p.35). Indeed, Function 1 discriminates nearly four times better than Function 2 (4.168 / 1.067 = 3.91). Functions 3, 4, 5 and 6 of the same MDA model (Table 8.1) have much lower discriminating power, and are not therefore worthy of further consideration. Eigenvalues are a non-scalar statistic, so they can be transformed to percentage of variance statistics. From this, it is shown that Function 1 accounts for nearly two thirds of the total variance of the six functions. That is, though Function 1 does discriminate for dependent variable, Functions 2 to 6 (in this particular example) also have degrees of discriminating 'power', though these are less than that exhibited by Function 1.

The canonical correlation figures reflect the degree of discriminating power of the derived functions. Again, Function 1, having a figure close to one reinforces its discriminating power. The Wilks' Lambda value for Function 1 also confirms this. In turn, the statistics associated with Functions 2 to 6 inclusively fail to discriminate as well as Function 1. Therefore, Function 1 is now discussed in greater detail.

Table 8.1
Canonical discriminant function coefficients and MDA results for grouping suppliers' turnover

Variable	Function					
	1	2	3	4	5	6
Q19N	0.756	-0.315	3.352	-1.834	0.267	-0.033
Q5N	0.849	-4.357	-1.901	-3.565	-1.118	2.349
Q5O	0.001	0.014	0.007	0.016	0.003	-0.010
Q8N	0.490	0.512	-0.183	-0.044	0.633	0.316
ZQ24N	-0.526	-0.158	0.300	0.541	0.076	0.764
ZQ4N	0.548	0.798	-0.103	-0.155	-0.616	0.447
Constant	-7.687	8.908	1.527	8.890	-0.419	-6.104

56.4 % of original groups correctly classified

Function	Eigenvalue	Percentage of variance	Canonical correlation	Wilks' Lambda	Chi-square
1	4.168	65.9	0.898	0.038	150.025
2	1.067	16.9	0.719	0.198	74.470
3	0.604	9.6	0.614	0.410	41.065
4	0.379	6.0	0.524	0.657	19.342
5	0.075	1.2	0.265	0.906	4.547
6	0.026	0.4	0.160	0.974	1.199

Standardised Canonical Discriminant Function Coefficients

Variable	Function					
	1	2	3	4	5	6
Q19N	0.195	-0.081	0.863	-0.472	0.069	-0.009
Q5N	0.641	-3.286	-1.433	-2.689	-0.843	1.771
Q5O	0.120	2.802	1.417	3.116	0.618	-2.012
Q8N	0.528	0.552	-0.197	-0.048	0.683	0.340
ZQ24N	-0.494	-0.148	0.282	0.508	0.071	0.718
ZQ4N	0.476	0.693	-0.089	-0.134	-0.534	0.388

Dependent variable Q3N

Based on observations of the standardised variables, it deduced that the best discriminating factor is: the number of credit accounts furnished (Q5N). Whilst the remaining factors discriminating power reduces in the following order: the percentage of credit accounts that have credit limits imposed on them (Q8N); whether suppliers would ask for guarantees of payment if a substantial order was placed (ZQ24N); the percentage growth / contraction the supplier experienced between 1995 and 1998 (ZQ4N); whether the supplier insured against bad debt, or not (Q19N); and the number of credit accounts furnished (Q5O).

The discriminating power of variables was deduced by observing factors standardised variables coefficients and ranking them (regardless of whether positive or negative): the greater the number size the greater the discriminating power.

8.3.2 Discussion of MDA results on suppliers' financial turnover

The overall accuracy of the MDA model was 56.4 per cent. Though this percentage identifies that there is a degree of error within the model, this has to be put in context. The dependent variable had eight classifications of turnover (see Appendix 8.1), meaning that the probability of correctly classifying a supplier's turnover was 12.5 per cent (100 / 8 = 12.5). Hence, the MDA model improved the accuracy of correctly classifying the dependent variable by over four times (56.4 / 12.5 = 4.51). When modelling the dependent variable with five leagues (as recommended by Oltman and Lackritz [op. cit.]) the overall accuracy of the model was relatively less than that achieved when using eight leagues. Hence, the eight-leagued model was given greater thought and analysis than the five-leagued model because greater detail could be inferred from it.

When considering the discriminating factors in isolation (see Appendix 8.1 for details of respective discriminating variable numerics), some interesting observations can be made. Suppliers who insure against bad debt (Q19N) are more likely to be in the higher turnover categories (compared to suppliers who do not insure). This statement is based on the knowledge that the positive function of Q19N, combined with the positive value of the MDA coefficient for this factor produce a figure that does not allow a supplier to be classified into a low turnover category. This indicates that suppliers who realise that bad debt can have a potentially catastrophic effect on their organisation's financial standing, are willing to pay a premium for this risk protection. In turn, insured suppliers tend to have 'larger' turnovers than compared to 'smaller' turnover suppliers, which may indicate that 'smaller' turnover suppliers are less risk aware than their 'larger' counterparts.

Regarding the number of credit accounts furnished (Q5N and Q5O), it is a logical finding that suppliers with a 'large' turnover interact with more contractors than compared to 'smaller' turnover suppliers. It may be argued that incorporating two factors into an MDA model that are perfectly correlated with one another is mathematically incorrect. However, since the MDA model is designed for practitioners' usage, which is constrained in terms of time and resources (Chapter 7), it has been decided to retain these discriminating factors, because they are easily and economically available.

The percentage of contractors that have credit limits imposed upon them (Q8N) discriminates well for classifying suppliers' turnover. Suppliers who impose credit limits on the majority of contractors defined as being 'creditworthy' tend to be those organisations with 'large' turnovers. Conversely, 'small' turnover organisations tend only to impose credit limits on a small percentage of creditworthy contractors. As with Q19N (suppliers who insure against bad debt), this finding indicates that 'large' turnover suppliers realise the risk they are exposing themselves to when they furnish credit and subsequently want to retain this risk within acceptable tolerances. 'Small' turnover suppliers are apparently more willing to expose themselves to greater risk than 'large' suppliers. Maybe, Q8N and Q19N highlight that 'small' turnover suppliers have to take on more risky situations, if they are to remain competitive with 'large' turnover suppliers? or, that this is a function of their accepting higher risk levels as a means of trying to expand their turnover? The latter seems a perfectly logical inference associated with this finding.

When considering the importance of whether suppliers would ask for guarantees of payment (if a contractor places a substantial order [ZQ24N]), the MDA model implies that those suppliers who do not, have larger turnovers. Since it has been identified that 'large' turnover suppliers tend to protect themselves with insurance against bad debt, and impose credit limits on the majority of their creditworthy contractors, then this later finding implies that 'large' turnover suppliers are still exposed to risk when large orders are placed. Ultimately, this insinuates that even 'large' turnover suppliers have to expose themselves to some risk, if they are to maintain the turnover level they desire. The opposing side of this argument is that if 'large' suppliers do not allow contractors to exceed their set credit limits, then there is no need for guarantees if a substantial order is placed. The caveat associated with credit limits is that organisations who suggest such limits (Credit registers, Banks etc.) fail to agree on a consensus figure of allowed credit for any given organisation, at a given point in time (Chapter 5). Hence, future research is required to determine which procedure classifies the risk more accurately; insurance and credit limits, or guarantees of payment?

There are caveats associated with the derived MDA model. For instance, no consideration has been given to the time duration that the suppliers (in the survey) have been trading. It may be the case that there is a time related characteristic of suppliers' existence that could help discriminate for turnover size. However, because this chapter represents only a small section of research aiming to define *how* to evaluate contractors' creditworthiness, factors relating only to suppliers' credit control and debt collection procedures have been modelled.

8.3.3 Interim conclusion: observations relating to suppliers' financial turnover

This section of the chapter has presented an MDA model for predicting the financial turnover class of materials suppliers. Using stepwise MDA it has identified that suppliers with a 'large' financial turnover tend to:

i. insure against bad debt;
ii. furnish credit to a large number of contractors;
iii. impose credit limits on as many contractors as they can;
iv. do not ask for guarantees of payment; and
v. have shown financial growth over their last three years' trading.

Conversely, suppliers with smaller financial turnover tend to exhibit the opposite characteristics. It is therefore possible to conclude that different (financial) sized suppliers do have significantly different characteristics. It should however be borne in mind, that large turnover suppliers are not immune to insolvency and reduced turnover, if continual bad business decisions are made. Similarly, small turnover suppliers could (potentially) evolve over time into large turnover suppliers.

Smaller turnover suppliers are exposed to greater amounts of risk (bad debt) than large organisations. This is because 'small' turnover suppliers tend only to protect themselves from incurring bad debt by, asking for guarantees of payment if a contractor places a large order. Suppliers with 'big' turnover tend to protect their interests by insuring against bad debt and imposing credit limits (on creditworthy contractors). This possibly implies that 'small' turnover suppliers 'know' the contractors they trade with, and thereby consider this knowledge as sufficient for them to make good decisions in this respect.

This section of the research has shown that 'small' turnover suppliers have to take on more risky business propositions, if they are to compete against 'large' turnover suppliers. In turn, this 'hunger' for winning contractors' trade means that materials prices are kept competitive. The findings also show that turnover class can be predicted with a degree of accuracy.

Having identified discriminating factors for suppliers' size of financial turnover, consideration is now given to the 'movement' (i.e. growth, contraction, sterility) of suppliers' turnover.

8.4 FORECASTING SUPPLIERS' FINANCIAL TURNOVER MOVEMENT

The underlying demand of business activity maintains that a 'good' return on capital employed be achieved, if investors are to maintain confidence (Smith, 1998). This implies that suppliers are encouraged to take risks, in order to try and achieve such return. If suppliers were to stop granting credit, then this would present them immediate problems, and, cause trading difficulties for the industry. Contractors would in particular be unable to raise sufficient working capital to finance the projects they are working on (or tendering for). Subsequently, the need for a model that could predict future movement of suppliers' financial turnover is evident. Given such a model, suppliers could more accurately monitor their financial 'support' to contractors; and minimise their risks associated with the same. Considering this one aspect alone, any model that could identify suppliers' key impacts on their turnover movement would be useful.

This section of the chapter presents two MDA models for the same dependent variable. The first MDA model classifies surveyed suppliers' growth / contraction over a three year period (1995-6, 1996-7 and 1997-8). The supplier growth / contraction groupings are of equal 'width' but the number of suppliers in each group is found to be unequal. The code used for this variable's identification is Q4CLGD. The second MDA model uses groupings with approximately equal numbers of suppliers in each group. That is, the respondent suppliers' compounded financial turnover movement was segregated into five leagues with approximately equal number of suppliers in each league. The identification coding used Q4CEQLSZ. The reasons these codings are detailed later.

8.4.1 Classification of suppliers' financial growth / contraction

From the survey conducted (Chapters 6 and 7) respondent suppliers detailed their organisation's percentage growth or contraction in turnover over three financial years (1995-96, 1996-97 and 1997-98). For each supplier, this data was transposed into a percentage for each year i.e. five per cent growth becomes 1.05; eight per cent contraction becomes 0.92 and so on. These three yearly figures were then multiplied together to give an indication of overall 'movement' in suppliers' financial characteristics. For example, five percent contraction, three percent growth and 12 percent growth over the three year duration represented an overall growth / contraction figure of: 0.95 x 1.03 x 1.12 = 1.096. Figures greater than one indicated that, on average over the time period considered, the supplier had increased their turnover; the integer 1 indicated no movement in turnover; and a figure less than one indicated turnover contraction (inflation ignored in these observations). For the example given, the supplier would be classified as having experienced 9.6 per cent financial growth for the period.

Having calculated this three-year consolidated figure for all respondent suppliers, they were then assigned a ranking depending upon their 'financial turnover characteristic' as detailed in Table 8.2. The first analysis (classification) used leagues of equal 'width'; that is, the growth / contraction groupings were equally spaced over the range observed (but no consideration was given regarding the number of suppliers in each league). The 'coding' for this classification is 'CLGD' suffixing the question number (4). The 'C' denotes suppliers' compounded three-year financial characteristic and 'LGD' denotes that the respondents' data was leagued. Table 8.2 shows the actual number of suppliers in each financial growth / contraction league.

The second MDA categorised growth / contraction of respondents so that there was approximately equal numbers of suppliers in each group (code used Q4CEQLSZ). By considering both of these analyses together, greater understanding of suppliers' financial growth / contraction characteristics is gained, than were the models examined in isolation. Further, utilisation of both of these leaguing techniques somewhat negates potential criticism of the MDA models having exaggerated accuracy (i.e. by only classifying the modal league correctly).

Table 8.2
Suppliers' compounded three year (1995-1998) financial characteristics

Dependent variable Q4CLGD

Supplier three year financial growth contraction characteristic (%)	*Actual Number of suppliers in group*	*Group number for MDA purposes*
56.0 to 79.2	1	1
79.3 to 102.4	8	2
102.5 to 125.6	34	3
125.7 to 148.8	7	4
148.9 to 172.0	5	5
TOTAL	*55*	

Dependent variable Q4CEQLSZ

Supplier three year financial growth contraction characteristic (%)	*Actual Number of suppliers in group*	*Group number for MDA purposes*
56.0 to 104.0	10	1
104.1 to 112.0	10	2
114.0 to 118.0	14	3
120.0 to 133.0	11	4
135.0 to 172.0	10	5
TOTAL	*55*	

The caveat so far with this methodology is that no account is taken for inflation. Since money has a time related aspect to its value (Pilcher, 1992; Sizer, 1989), any calculations to accurately define movements in organisations' financial turnover characteristics needs to incorporate such. During the period 1995 to 1998 the 'time value of money' reduced by 9.26 per cent (Office for National Statistics, 1999). To take account of this, a second time-dependent variable was calculated by dividing each suppliers' summated growth / contraction figure by 1.0926. Group numbers, were reassigned to suppliers' three-year financial turnover characteristic using this 'time related variable'. A discriminant analysis was then carried out. The result of the MDA analysis using 'time related data' was a model with an ability to correctly classify 3.6 per cent of survey respondents' financial turnover characteristics. This model provided less accuracy than pure guesswork so it was rejected and the dependent variable in its 'non-time' related aspect was concentrated upon.

Supplier financial turnover movement is the dependent variable considered in this section of the thesis. This is because traditional wisdom suggests that organisations that have financial growth tend to have a reduced probability of insolvency compared to those with negative financial movement. Russell and Zhai (1996) investigated the relationship between contractor failure and (their) financial characteristics. It was found that contractors who had positive growth in their net worth, gross profits and net working capital, were significantly less likely to become insolvent than contractors with negative movements in these characteristics. Admittedly, suppliers are different to contractors, but the lack of previous research into their (suppliers) dynamics (Chapter 3) necessitates these comparisons with contractors. Ultimately, positive turnover trend indicates that the organisation is capable of keeping 'in tune' with market demands. The results of both MDA analyses are now discussed.

8.4.2 Results of data analysis associated with suppliers' turnover movement

MDA results for predicting Q4CLGD (equal banding widths of suppliers growth / contraction characteristics) are shown in Table 8.3. Insuring against bad debt (Q19N); the specialist field of construction that the supplier supplies materials to (Q1N); the methods used to establish contractor credit limits (Q9N); the geographical region of those contractors that are supplied (Q2N); and the maximum acceptable percentage of credit sales lost in bad debt (Q21O) are all best predictors to Q4CLGD.

The eigenvalue results show the order of function importance. The eigenvalue for function 1 (0.694) shows that that it has nearly twice as much discriminating power than function 2 (0.392) and that function 4 (0.065) is statistically weak compared to function 1. By reviewing the statistics for the cumulative percentage of variance statistics it is shown that function 1 has the highest discriminating power of the functions listed (52.200). Though function 1 has only 52.2 per cent discriminating power it has to be borne in mind that the data for this analysis is based *only* on suppliers' credit control and debt collection practices. That is, no consideration has been given to the suppliers' management attitudes or relationships with their clients. The canonical correlation statistic for function 1 (0.640) shows that there is some discrepancy between the discriminating function and the dependent variable; for perfect discrimination the canonical correlation would be 1. When considered in tandem with Wilks' lambda and chi-squared transformation (0.338 and 52.069 respectively) it can be concluded that function 1 proves to be relatively accurate in predicting supplier turnover movement. The overall accuracy of 58.18 per cent indicates that by using the discriminant function, the probability of correctly classifying suppliers' financial growth / contraction is nearly trebled (58.18 / 20.00 = 2.91) than if guesswork had been employed i.e. no prior probability statistics were used. As mentioned previously, this analysis ignores the number of suppliers in each group, so there is potential for arguing that the MDA functions presented so far are flawed i.e. by correctly classifying the modal turnover movement league correctly would over exaggerate the accuracy of the model. Therefore, the following analysis used groupings that have approximately equal numbers of suppliers in each.

Table 8.3
Discriminant results for predicting suppliers' financial growth characteristics: equal group widths of financial growth

Canonical Discriminant Function	*Eigenvalue*	*Cumulative Percentage of Variance*	*Canonical Correlation*	*Wilks' Lambda*	*Chi-square*
1	0.694	52.200	0.640	0.338	52.069
2	0.392	81.700	0.531	0.573	26.763
3	0.178	95.100	0.388	0.797	10.892
4	0.065	100.000	0.248	0.939	3.038

58.18% of original grouped cases correctly classified

Canonical Discriminant Function Coefficients

Variable	Function			
	1	2	3	4
Q19N	0.435	-0.310	-2.087	2.452
Q1N	-0.182	0.620	0.140	0.374
Q9N	-0.498	0.112	0.293	0.072
Q2N	0.106	-0.217	0.176	0.201
Q21O	208.977	85.455	12.706	6.453
Constant	-1.117	-0.617	0.454	-4.454

Standardized Canonical Discriminant Function Coefficients

Variable	Function			
	1	2	3	4
Q19N	0.135	-0.096	-0.648	0.762
Q1N	-0.242	0.823	0.186	0.497
Q9N	-0.557	0.126	0.328	0.080
Q2N	0.300	-0.612	0.496	0.567
Q21O	0.932	0.381	0.057	0.029

Dependent variable Q4CLGD

For analysis based upon approximately equal number of suppliers in each group, the following variables were found to be the best predictors of turnover movement: the average time spent evaluating each contractor's creditworthiness (Q11N); the percentage of turnover per annum that suppliers' credit control departments cost (Q13N); suppliers' standard terms of payment (Q14N); suppliers' percentage of bad debt to sales in financial year (1997-8) (Q16O); the type of trade that the supplier most often interacts with (Q1N); and the geographical region that materials are supplied to (Q2N) (Table 8.4).

Table 8.4 shows that the chi-squared values for discriminant functions 1 to 3 inclusive have statistically high levels of discriminating power at the five per cent level. Function 4 (only contributing 4.2 percent towards the total percentage variance) proves insignificant. Discriminating powers of the functions in Table 8.4 are confirmed by 56.4 per cent of suppliers' financial characteristics being correctly classified. By comparing the second MDA model to the first, it is found to have a similar ratio of 'predictive' accuracy to guesswork (56.4 / 20.0 = 2.82). With the knowledge that the cost of suppliers' credit control and debt collection departments typically represent less than one per cent of turnover (Chapter 7), this does suggest some form of link between this department's activities and those of the supplier's turnover movement.

Application of the derived MDA model to the independent hold-out sample (ten suppliers were used in this respect), resulted in six out of the ten suppliers for both MDA models relating to suppliers' turnover movement being classified correctly. These results closely resemble those obtained by the initial discrimination models' results. It is possible to conclude that despite the data not exhibiting normality or equal covariances, the models performed with reasonable accuracy.

8.4.3 Interim summary: results relating to suppliers' turnover movement

The MDAs fail to produce perfect results; there is an element of 'noise' within each. This section of the chapter considers and discusses 'logical' associations between the dependent and independent variables.

Table 8.4
Discriminant results for predicting suppliers' financial growth characteristics: approximately equal number of suppliers in each group

Canonical Discriminant Function	*Eigenvalue*	*Cumulative Percentage of Variance*	*Canonical Correlation*	*Wilks' Lambda*	*Chi-square*
1	0.870	52.7	0.682	0.272	61.774
2	0.391	76.4	0.530	0.509	32.040
3	0.320	95.8	0.492	0.708	16.378
4	0.070	100.0	0.255	0.935	3.196

56.36% of original grouped cases correctly classified

Canonical Discriminant Function Coefficients

Variable	Function 1	2	3	4
Q11N	-0.943	-0.030	0.663	0.804
Q13N	1.524	0.261	0.864	0.272
Q14N	0.909	0.508	0.502	0.377
Q16O	-80.166	28.971	16.041	52.606
Q1N	-0.292	0.705	-0.347	-0.021
Q2N	0.116	-0.113	-0.272	0.189
Constant	-3.267	-2.549	-2.007	-3.739

Standardized Canonical Discriminant Function Coefficients

Variable	Function 1	2	3	4
Q11N	-0.659	-0.021	0.464	0.562
Q13N	1.041	0.178	0.590	0.186
Q14N	0.759	0.424	0.419	0.315
Q16O	-0.609	0.220	0.122	0.400
Q1N	-0.377	0.909	-0.448	-0.027
Q2N	0.326	-0.318	-0.763	0.531

Dependent variable Q4CEQLSZ

Function 1 for both analyses performs best in discriminating for the dependent variable. Consideration is therefore only given to the first functions in the following paragraphs.

For the MDA analysis with Q4CLGD as the dependent variable it can be seen from Table 8.3 that Q21O (suppliers' maximum acceptable bad debt to credit sales) has the largest amount of discriminating power. The larger this (standardised) variable's numeric (regardless of whether positive or negative), the more this variable discriminates (Klecka, 1987 p.29-30). Following from Q21O; Q9N (methods used by supplier to define contractor credit limit), Q2N (geographical region that materials are supplied to), Q1N (the construction trade the supplier interacts with) and Q19N (suppliers' attitude to insuring against bad debt) are found to possess reducing discriminating power, in this same order.

By considering each variable in turn for the MDA analysis of Q4CLDG some interesting observations are made. See Appendix 8.2 for the respective discriminating variable coefficients.

The results imply that suppliers who perceive greater amounts of debt as 'acceptable' (Q21O) are likely have larger financial growth. However, one is mindful that there is a fine balance needed between such risk and the rewards associated with increasing turnover.

The methods used for establishing credit limits (Q9N) have a negative canonical discriminant function coefficient (see Table 8.3). This suggests that the discriminating variables with a 'large' numeric associated with Q9N are not as highly associated with suppliers who have experienced financial turnover growth, when compared to suppliers who have zero growth or financial turnover contraction. Hence, suppliers with financial growth most often use credit registers. However, survey responses from which this analysis emanated showed that over half of respondents using credit registers perceived their accuracy as only 'poor' or 'average' (Chapter 7).

The discriminating variable code for the region where suppliers' supply materials to (Q2N) combined with the canonical discriminant function coefficient suggests that those suppliers who interact with contractors in either the Midlands, North East, North West or East incurred greater financial turnover growth than suppliers who traded in other regions of the UK (see Appendix 8.2). Within the survey, the criterion for being defined as trading on a Nation-wide basis was to do business with two or more of the geographical regions listed. Maybe this result suggests that suppliers should concentrate their resources on gaining maximum market share in one particular geographic region rather than seeking trade from contractors throughout the UK?

Regarding the trade(s) that suppliers most often interact with (Q1N), its associated statistics suggest that specialising in supplying materials to one particular construction trade, assists in increasing supplier financial turnover. Further, if the particular trade was one of the low numbered coefficients (as detailed in Appendix 8.2), then this also assisted financial growth.

The final variable associated with discriminating for Q4CLGD is whether the supplier insured against bad debt (Q19N). Those suppliers who did insure tended to have greater financial growth than compared to those that did not insure. When considering this finding in tandem with the amount of debt perceived as acceptable

(Q21O), it suggests that those suppliers who perceive larger amounts of debt as acceptable, but take out insurance to protect themselves in this respect, were more likely to achieve financial growth than had they adopted an alternative viewpoint.

For the second derived MDA model which had approximately an equal number of observations in each group (Q4CEQLSZ) the order of discriminating importance of the variables were: Q13N, Q14N, Q11N, Q16O, Q1N and Q2N (Table 8.4).

The cost of suppliers' credit control department (Q13N) is related to their financial turnover characteristics. The more a supplier's credit control and debt collection department costs to run, the greater that supplier's turnover growth tends to be. This is a relatively logical finding because those suppliers who realise the advantages of operating an effective credit system can gain competitive advantage and potentially reduce the amount of bad debt they incur. This is an important finding per-se.

Suppliers' standard terms of payment (Q14N) show that by collecting debt quickly, then financial growth is assisted. An 'end of the month of delivery' payment term is found most conducive to assisting financial growth.

The negative canonical coefficient associated with Q11N (the time-spent evaluating a contractor's creditworthiness) implies that those suppliers who spend considerable time on this task negatively assist their organisation's financial growth. This is an interesting result; it would have been thought that those who spent time evaluating a potential debtor would benefit from the extra knowledge gained. The finding associated with Q11N implies that if little time is spent evaluating contractors' creditworthiness, this results in increased turnover. However, the unknown risk that this induces has to be compensated for by spending money on the supplier's credit control and debt collection department running costs (Q13N). Maybe it is the case that concentrating on 'collection of debt' has benefits that outweigh those associated with trying to evaluate contractors' creditworthiness?

The variable associated with suppliers' percentage of bad debt in financial year 1997-8 (Q16O) identifies that those who suffered less bad debt were more likely to experience financial growth.

The results in the second MDA model (Q4CEQLSZ) for variables Q1N and Q2N (the trade and region the supplier operates in) imply the same association between supplier financial growth / contraction as the first MDA model (Q4CLDG).

8.4.4 Conclusion relating to suppliers' turnover movement

The MDA models described so far in this section of the chapter have shown that discriminant analysis can retain its 'predictive' accuracy when normality and equal covariance is not inherent in the data. Two MDA models have been presented. They have shown to contribute significantly towards correctly classifying the turnover trend of materials suppliers. Both models are nearly three times more likely to correctly classify a supplier's growth / contraction than had guesswork alone been utilised.

The first model allows an equal probability of a supplier's financial characteristics being in one of the five leagues derived, which were based on the range of growth /

contraction exhibited by survey respondents. The second model complements the first, by grouping suppliers into approximately equal groups - depending on their financial characteristics. By using both MDA models in tandem, the knowledge of supplier financial growth / contraction can be ascertained with relative accuracy.

The common conclusion between both (derived) models is that financial growth is more likely if suppliers are willing to accept greater amounts of financial risk. However, one is mindful that if this is taken to an ultimate conclusion, bad debt may outweigh the benefits from such increase in turnover, so a careful balance is required. Practitioners could use the MDA models to provide an idea of how they can improve their turnover.

It has to be borne in mind that the survey data from which the MDA models derive was obtained at a time of general economic prosperity (1998). Because the economic environment inevitably influences suppliers' characteristics, research should be carried out under different economic 'conditions' to identify if findings produced in this chapter remain to hold true.

The models do have an element of error within their predictive ability, but they represent research that has for the first time, proved that suppliers' financial turnover can be expanded by increasing the level of risk associated with granting contractors credit. Essentially, the MDA models underpin the theory of entrepreneur-ship: with risk comes reward. The results presented could inevitably assist entrepreneurs in optimising their resources; which in turn has benefits for the entrepreneur as well the general UK economy.

8.5 PREDICTING SUPPLIERS' BAD DEBT

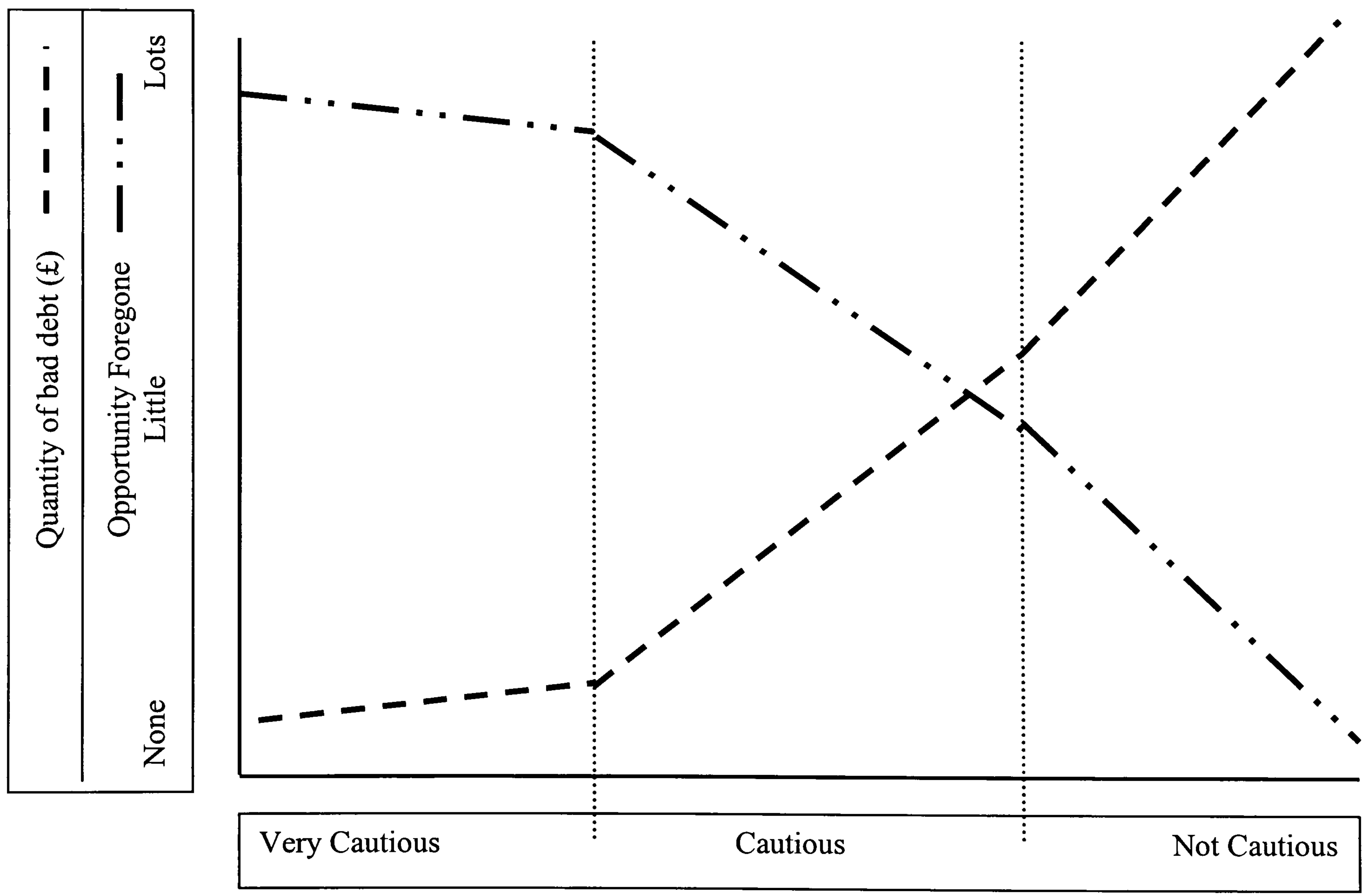
Present methods for evaluating contractors' creditworthiness are ad hoc and bespoke (Chapter 2). As such, materials suppliers place themselves in a position of considerable risk when they furnish contractors with credit. Very often, the result of this is bad debt for the supplier. This section of the chapter presents two multivariate discriminant analysis models. The first, models suppliers' percentage bad debt incurred in financial year 1997-8. The second model complements the first by investigating the relationship between suppliers' targeted profit margins minus bad debt they incurred in the time period mentioned.

When materials suppliers furnish contractors with credit, they do so in the hope that those contractors will honour their debts. When a contractor fails to make a repayment on time, the supplier incurs costs, for example, associated with debt collection. In extreme circumstances (i.e. where a debt is outstanding for a long period) eight hierarchical levels of debt collection procedure could have been initiated by the supplier (Chapter 7). Logically, the longer a debt is outstanding, the more costly it becomes for the supplier to collect. Subsequently, in such circumstances the benefit from granting credit (targeted profit level and utility gain) is eroded and in extreme cases eliminated. It is therefore important from the suppliers' standpoint to minimise bad debt, or at least balance bad debt against profit generated.

Stern (1999) suggested that there are tax benefits to be gained when incurring debt. This is because under the UK tax system, equity is taxable and debt is not. Thus, there is a sophistic philosophy that debt is cheaper than equity. This is not true. Debts should always be minimised, thereby assisting company cash flow and gearing ratios.

Having justified the need for this specific research into suppliers and bad debt, it is helpful to consider the converse side of the issue (i.e. if bad debt were eliminated altogether). If such a situation were to occur, then this possibly means that the supplier is being overcautious and may be missing out on possible avenues of profit. This concept of 'cautiousness' can be considered graphically (see Figure 8.1) from which it is possible to segregate cautiousness into three distinct zones. As the degree of cautiousness decreases, so the amount of bad debt increases, and vice-versa. At present, due to a lack of research in this aspect the lines on Figure 8.1 is conveniently expressed in a linear manner. Future research is needed to investigate the function of these cautiousness / bad debt gradients to identify their mathematical characteristics. Undoubtedly, a factor that will influence their shape and gradient will be the volume of trade foregone in not allowing a contractor(s) credit. In Figure 8.1 the opportunity-foregone line is shown. If the opportunity-foregone line and the cautiousness lines could be accurately placed on identical graph axes, then the intersection of these two would indicate the optimum point for decisions to be gauged regarding whether to furnish credit, or not.

Figure 8.1
Bad debt versus degree of cautionsness versus opportunities foregone



From this conceptual framework, it is evident that the quantification (i.e. prediction) of creditors' (suppliers') bad debt would inevitably be beneficial. Two multivariate discriminant (MDA) models are now presented to assist in such a task. The first model discriminates for suppliers' percentage bad debt incurred in financial year 1997-8. The second model complements the first and discriminates suppliers' targeted percentage profit (minus percentage bad debt incurred) for the same period.

The survey question relating to bad debt had six categories (leagues) that suppliers could offer a response to. Based on the stratification of responses to this question, it was decided to retain six leagues for the first MDA analysis. For the second analysis (profit minus bad debt), it was decided to league suppliers' responses.

Tables 8.5 and 8.6 show the number of suppliers in each league for both dependent variables. It can be seen that the majority of suppliers suffered less than one per cent bad debt on turnover in financial year 1997-8. This result may suggest that there is little need to investigate suppliers' credit control and debt collection procedures. However, it should be borne in mind that the survey was undertaken at a time of general economic prosperity (1998) and this would have influenced suppliers' responses. Further, it may be argued that by correctly classifying the modal bad debt category in Table 8.5, this would provide an MDA model with an exaggerated accuracy. To counteract such argument, a second MDA model with approximately equal numbers of observations in each group for the dependent variable, was obtained via observing suppliers' targeted profit margin minis bad debt encountered (Table 8.6).

Table 8.5
Dependent variable (Q16N): numbers of observations in each league and MDA code

Suppliers' percentage bad debt encountered (Q16N)	Number of Observations		MDA code
≤ 1%	43	(79.6)	1
≥1.01 and under 2%	8	(14.8)	2
≥2.01 and under 3%	2	(3.7)	3
≥3.01 and under 4%	0	(0.0)	4
≥4.01 and under 5%	0	(0.0)	5
≥5.01% and over	1	(1.8)	6
TOTAL	*54*		

Figures in parenthesis indicate percentage observations

Table 8.6
Dependent variable (Q17N-Q16N): numbers of observations in each league and MDA code

Suppliers' targeted percentage profit – bad debt encountered (Q17N-Q16N)	Number of Observations		MDA code
-0.5 to 2.5%	10	(18.5)	1
2.51 to 5.5%	10	(18.5)	2
5.61 to 8.5%	11	(20.3)	3
8.51 to 11.5%	8	(14.8)	4
11.51 to 14.5%	15	(27.8)	5
TOTAL	*54*		

Figures in parenthesis indicate percentage observations

Regarding the second dependent variable, i.e. suppliers' targeted percentage profit margin minus percentage bad debt incurred (Q17N-Q16N), it is interesting to note from Table 8.2 that one of the response categories has a negative number. This implies that suppliers' percentage bad debt incurred, exceeded that of the targeted profit margin. Ultimately, if this scenario continued for any period of time, supplier cash flow would become negative and the supplier's survival questionable. The second interesting observation with this dependent variable is the approximate equal number of suppliers in each league, whilst the league 'widths' remain constant. There are a number of suppositions that can be made from this:

i. contractors should seek keen materials quotes from a number of suppliers;

ii. it may be possible to negotiate discounts from some suppliers;

iii. some suppliers must be either:

   - be taking advantage of discounts when buying in bulk and keeping inventory costs down;
   - operating a monopoly; or
   - not taking advantage of what the market is willing to pay.

iv. Finally, if the price mechanism is working correctly (supply and demand) it means that some suppliers are operating more efficiently than others (if costs of materials sold to contractors are approximately equal).

Evidently, future research is required to answer these questions.

8.5.1 Results of data analysis associated with suppliers' bad debt

Having carried out the MDA analysis, models with 70.9 and 47.3 per cent accuracy respectively were determined. That is, the 70.9 per cent accurate model used suppliers' percentage bad debt incurred in financial year 1997-8 as the dependent variable; whilst the 47.3 per cent accurate model used suppliers' targeted percentage profit minus percentage bad debt incurred as the dependent variable. The independent hold out sample of ten resulted in seven and four of the organisations being correctly classified (as to the amount of bad debt they had incurred and suppliers' percentage profit minus percentage bad debt respectively). Once again, though the data used for the models was not 'statistically ideal' (regarding normality and equal covariances), the results of the MDA models do portray discriminating characteristics that closely resemble the hold out sample's attributes.

Having identified that the MDA models have ability to discriminate for the dependent variables, the statistical results are now presented and discussed.

Concentrating firstly on dependent variable Q16N (suppliers' percentage of bad debt incurred in financial year 1997-8). Perfect discrimination is identified by a Wilks' lambda of zero; as lambda increases towards a value of 1.0 the value of the discriminating function looses its accuracy. Hence, from the results in Table 8.7 it can be seen that Function 1 performs better than Function 2. To test the significance of Wilks's lambda the chi-square statistic is calculated (Table 8.7). The chi-squared statistic allows comparisons with statistical tables and thereby induces a greater understanding of the significance of the derived MDA functions. From Table 8.7 the chi-square statistic for Function 1 is highly significant (sig. 0.004). However, Function 2 fails to produce such statistical significance (sig. 0.55). These results show that Function 1 has a better ability to discriminate for the dependent variable than compared to Function 2.

When reviewing the eigenvalues for the two functions it is evident that Function 1 performs 25 times better than Function 2 (0.600 / 0.024). Good discriminating functions have large eigenvalues (Klecka, 1987 p.35). As eigenvalues' importance cannot be directly interpreted, they are converted into cumulative percentages of variance. From Table 8.7 it can be seen that Function 1 accounts for over 96 per cent of the total variance of the two functions. Subsequently, Function 2 accounts for less than four per cent of the variance: again identifying that Function 1 is relatively powerful.

Table 8.7
MDA results for predicting suppliers' percentage bad debt in financial year 1997-8: Q16N

Discriminant Function	Eigenvalue	Cumulative Percentage of Variance	Canonical Correlation	Wilks' Lambda	Chi-square
1	0.60	96.10	0.61	0.61	24.69
2	0.02	100.00	0.15	0.98	1.19

70.9% of original grouped cases correctly classified

Canonical discriminant function coefficients

Variable	Function	
	1	2
Q18N	5.10	0.76
Q7N	-2.18	2.13
Constant	-3.63	-8.07

Dependent variable Q16N

Standardised canonical discriminant function coefficients

Variable	Function	
	1	2
Q18N	1.20	0.18
Q7N	-0.83	0.89

Considering the canonical correlation results, it can be seen that Function 1 continues to out-perform Function 2.

8.5.2 Discussion of MDA results associated with suppliers' bad debt

Having presented the statistics associated with the derived MDA model for Q16N, the discriminate variables are now discussed. Appendix 8.3 details the respective discriminant variables' numerics.

The MDA model suggests that those suppliers who do not employ a standard procedure for collecting overdue debt (Q18N) incurred less bad debt than those who did. Maybe this identifies that contractors who trade with suppliers who have a standard debt collection procedure realise this and ignore reminders for repayment! Subsequently, contractors are allowed to build up large amounts of bad debt and are either declared insolvent or the supplier decides that the expense in collecting the debt outweighs the benefits from such recovery? It is hypothesised that this last scenario is highly unlikely, especially considering the issues discussed at the outset of this chapter. Another option may be that although the supplier carries out debt collection according to prescribed procedures, they do not effectively portray to the contractor the need for debt repayment. Finally, it has been identified that some suppliers employ a standard debt collection procedure that evokes eight hierarchical levels (Chapter 7). Maybe this number of levels is too great, and if this were reduced to two levels (e.g. telephone calls followed by court summons) contractors would honour their contract terms more expediently? The problem with this option is that it is not very 'friendly' and may be prejudicial to the building of long term supplier / contractor relationships. Regardless of which option is decided upon, the MDA model infers that standard debt collection procedures are ineffective. Therefore, suppliers need to employ a procedure that is effective but that does not necessarily follow a set pattern.

Suppliers who *always* check on the creditworthiness of contractors before granting them credit tended to incur under 1 per cent of bad debt to sales in 1997-8 (Q7N). Suppliers who *sometimes* or *never* check on the creditworthiness of contractors tend to incur greater amounts of bad debt. These results are expected. If a supplier can evaluate a contractor's creditworthiness and make an objective decision as to whether they will get paid if credit is allowed, then this inevitably reduces the probability of incurring bad debt.

Of the two discriminating variables, the one that contributes the most towards correctly classifying suppliers' bad debt is Q18N (suppliers who have a standard procedure for collecting overdue debts). This variable contributes nearly fifty per cent more accuracy to the model than Q7N (suppliers' attitude towards checking the creditworthiness of contractors before granting them credit). This statement is based on observations of the standardised variables.

8.5.3 Results of data analysis associated with suppliers' targeted profit margin minus bad debt incurred

When considering results obtained for the dependent variable: suppliers' targeted profit margin bad debt incurred (Q17N-Q16N), it can be seen from Table 8.8 that Function 1 is by far the most powerful discriminator. The order of discriminating 'power' of the variables is obtained from the standardised coefficients and are in descending order:

i. the method used for establishing credit limits for contractors (Q9N);
ii. suppliers' three year percentage growth / contraction on turnover (1995-1998) (Q4N);
iii. suppliers' who insure against bad debt (Q19N);
iv. the terms of payment a supplier imposes on credit accounts (Q14N); and,

v. whether a supplier would ask for a guarantee of payment if a substantial order was placed (Q24N).

Table 8.8
MDA results for predicting suppliers' percentage targeted profit - percentage bad debt in financial year 1997-8: Q17N-Q16N

Discriminant Function	Eigenvalue	Cumulative Percentage of Variance	Canonical Correlation	Wilks' Lambda	Chi-square
1	1.000	80.4	0.707	0.399	44.151
2	0.184	95.2	0.394	0.797	10.855
3	0.058	99.9	0.235	0.944	2.767
4	0.001	100.0	0.029	0.999	0.041

47.27% of original grouped cases correctly classified

Canonical discriminant function coefficients

Variable	Function			
	1	2	3	4
Q14N	0.657	1.104	-0.257	-0.167
Q19N	-1.914	1.406	1.751	0.744
Q24N	0.622	0.227	0.775	0.550
Q4N	0.846	-0.280	0.661	-0.817
Q9N	0.839	-0.182	0.024	0.511
Constant	-5.032	-3.493	-4.656	-0.528

Dependent variable Q17N-Q16N

Standardised canonical discriminant function coefficients

Variable	Function			
	1	2	3	4
Q14N	0.514	0.864	0.201	-0.131
Q19N	-0.595	0.437	0.544	0.231
Q24N	0.428	0.156	0.533	0.379
Q4N	0.659	-0.219	0.515	-0.636
Q9N	0.856	-0.185	0.025	0.521

Considering these variables in isolation, and making a generalisation that suppliers having a higher 'coded' dependent variable are 'better' performers than those with converse characteristics, allows the following suppositions to be made (Appendix 8.3 details the relative discriminant variables' numerics).

Suppliers who impose 'end of the month of delivery' terms of payment onto contractors (having credit accounts), tend to aim for 'better' returns on capital employed (Q14N). It is interesting to note that the majority of suppliers (67.9 per cent) surveyed used 'end of the month after delivery' terms (Chapter 7).

Insuring against bad debt (Q19N) tends not to assist in returning profit after bad debt is taken into account. Possibly, this insinuates that those organisations that do insure against bad debt have to reconcile this protection against the level of profit aimed for, if they are to remain competitive?

Suppliers who always ask for guarantees of payment when a substantial order is placed (Q24N) tend to positively assist their net profit levels. Considered in tandem with the observation regarding insuring against bad debt, it is possible to question if the financial risk associated with a 'normal' (£) size order (placed by a contractor with credit), should be accepted as being within a supplier's tolerable risk level. However, if the order exceeds the 'normal' quantity (£), then should guarantees of repayment be sought? Only future research can answer this question.

Those suppliers who experienced growth in sales turnover for the period tended to be more likely to be associated with larger net profits, than those suppliers who experienced turnover contraction.

Finally, suppliers who used two or more methods to establish credit limits for each contractor (furnished credit), assisted the supplier being classified into the higher net profit leagues.

8.5.4 Conclusion associated with suppliers' bad debt

This section of the chapter has presented two MDA models. One for predicting the degree of bad debt that suppliers incurred (in financial year 1997-8) and a second to predict suppliers' targeted profit margin (minus bad debt). The first model identified that if suppliers do have a standard procedure for collecting overdue debt then, surprisingly, they tend to incur greater debt than if no standard procedure was employed. A logical result was obtained regarding suppliers who check the creditworthiness of contractors before granting them credit. Those who *always* carry out such checks tend to incur less debt than those who only *sometimes* or *never* check on the creditworthiness of a potential debtor. The second model identified that those suppliers who:

i. sought fast collection of a debt;
ii. did not insure against bad debt;
iii. always asked for guarantees of payment if a substantial order was placed;
iv. had growth in financial turnover from 1995 to 1998; and
v. used two or more methods for establishing credit limits,

had a greater probability of returning larger net profits than those suppliers with converse characteristics.

A conceptual framework has also been presented regarding the incidence of bad debt for suppliers. Since the benefits (profit) gained from furnishing a contractor with credit are relatively small in comparison to the value of goods at risk, suppliers need to maintain a fine balance between 'worthwhile' risk and excessive risk.

The underlying theme of this section of the chapter is that bad debt needs to be carefully controlled. Excessive bad debt means reduced profit for the supplier, and since these organisations provide the industry with a form of working capital, the need for their continued survival is paramount. Investigation into risk associated with furnishing contractors with credit can only be beneficial to such organisations.

8.6 PREDICTING MATERIALS SUPPLIERS' PROFIT MARGINS

This section of the chapter models suppliers' credit control and debt collection practices and characteristics to predict the (average) annual profit that will result from purveying credit to a contractor[1]. Suppliers must obviously generate profit to ensure continued survival, so greater understanding of potential profit enhancement would be welcomed, particularly, when one considers the volatile environment within which construction operates.

This component of the research identifies and investigates the discriminating variables that best model the targeted quantity of profit, from each individual credit account furnished by a supplier. Dependent variables that failed to produce significantly good discrimination functions are also discussed. The reason for

[1] *Targeted quantity of profit is possibly different from 'actual' profit achieved. However, the variable (target profit level) aims to consider suppliers' attitude towards furnishing contractors with credit before variables that adversely affect this factor are considered.*

inclusion of this 'negative' aspect of the research, is that it provides additional insight to those data analysed and hence, the subject domain in general.

The UK operates under an economic capitalist system, so targeted profit margins are important to consider. Essentially, they underpin the economic concept of profit maximisation. Bell (1989) confirmed that the ethos of financial management was to make profits. Raven (1973) evokes that profit maximisation is 'king' and any department that can assist in achieving this, generally, also positively contributes to broadening the organisation's trade base and increasing turnover. Peters and Waterman (1989) regard profit as a key desire for any business, but revoke it as being an elixir, stating:

> *'... it's not why you exist'*

More recently, Smith (1998) commented on A. T. Kearney's study (1998) into British companies' economic behaviour. It was reported that companies included in the FTSE 100 share index have shown impetus to increase profit margins and provide bigger returns on capital employed (albeit regardless of the influences this has had on any growth in revenue). Having deduced that influences on profit margins are worthy of investigation, Sloman (1994) contended that the main problem with achieving desired profit levels is a lack of information, regarding how to actually go about this. The research contained in this section contributes to rectifying this void in the knowledge domain.

8.6.1 Results of data analysis associated with suppliers' targeted profit margins

It can be seen from Table 7.13 that suppliers' targeted profit margins were classified into one of eight groupings. When using this variable as the 'dependent' and conducting a stepwise MDA, an overall classification accuracy of 3.6 per cent was obtained. This degree of accuracy has no practical use, so this model was rejected.

By subsequently grouping suppliers' targeted profit margins into four groups of approximately equal size (i.e. 0-4, 4.01-8, 8.01-15, and 15 per cent and over) an MDA model with an accuracy of 3.6 per cent was again obtained. Similarly, this is insufficiently accurate to be useful.

When investigating the targeted quantity of profit per credit account furnished, a model with 78.18 per cent overall accuracy was obtained. This is a good degree of accuracy, since, for example, uneducated guesswork would generally classify only twenty per cent correctly if five leagues of the dependent variable were used (100/5 = 20 per cent). An independent hold-out-sample of ten suppliers confirmed this accuracy by correctly classifying nine organisations' (suppliers') targeted profit per contractor furnished with credit. This later model is now discussed, and associations between discriminating variables considered.

To obtain the dependent variable the following formulae were used:

Supplier turnover (£) x Percentage of turnover accounted for by credit sales = £ credit sales (Formula 8.9)

£ credit sales / Number of credit accounts furnished = Materials value sold per credit account (average) (Formula 8.10)

Materials value sold per credit account (average) x *percentage target profit margin* = *Mean targeted profit (£)from each credit account furnished* (Formula 8.11)

Having obtained the new dependent variable (*Mean targeted profit (£) from each credit account furnished*) for each supplier, this ranged from £10.63 to £3,187.50. When leaguing the data into five classes (from Formula 8.11), the majority of suppliers aimed to make between £10.63 and £646.00 per account, per financial year (Table 8.9). By investigating for association between the dependent variable (coded p£/c^{tr}) and suppliers' turnover, a Spearmans rho statistic of 0.70 was obtained ($P<0.01$). It may be argued that this correlation identifies that p£/c^{tr} is not totally independent when MDA is carried out. However, Graph 8.1 identifies that there are 17 permutations associated with these variables and suppliers whose turnover is $\geq$ £25m had greater variance in terms of p£/c^{tr} than any other class of supplier (i.e. turnover range). Hence, despite correlation, classifying suppliers into different dependent variable leagues (p£/c^{tr}) cannot be based solely on supplier turnover characteristics. To eliminate any criticism of the model 'only' classifying the modal league correctly, a second MDA model was derived. This model used the same dependent variable but had five leagues with an approximately equal number of observations in each (Table 8.10). The results of this MDA are discussed later. The code used for this second dependent variable's identification was '=p£/c^{tr}'.

Table 8.9
Suppliers targeted profit (£) to be made from each furnished credit account ($p£/c^{tr}$)

Targeted Profit	Frequency	Percentage Frequency	MDA Code
£10.63 - £646.00	33	60.0	1
£646.01 - £1,281.38	11	20.0	2
£1,281.39 - £1,916.75	3	5.5	3
£1,916.75 – £2,552.13	3	5.5	4
£2,552.14 – 3,187.50	5	9.1	5
TOTAL	*55*	*100.0*	

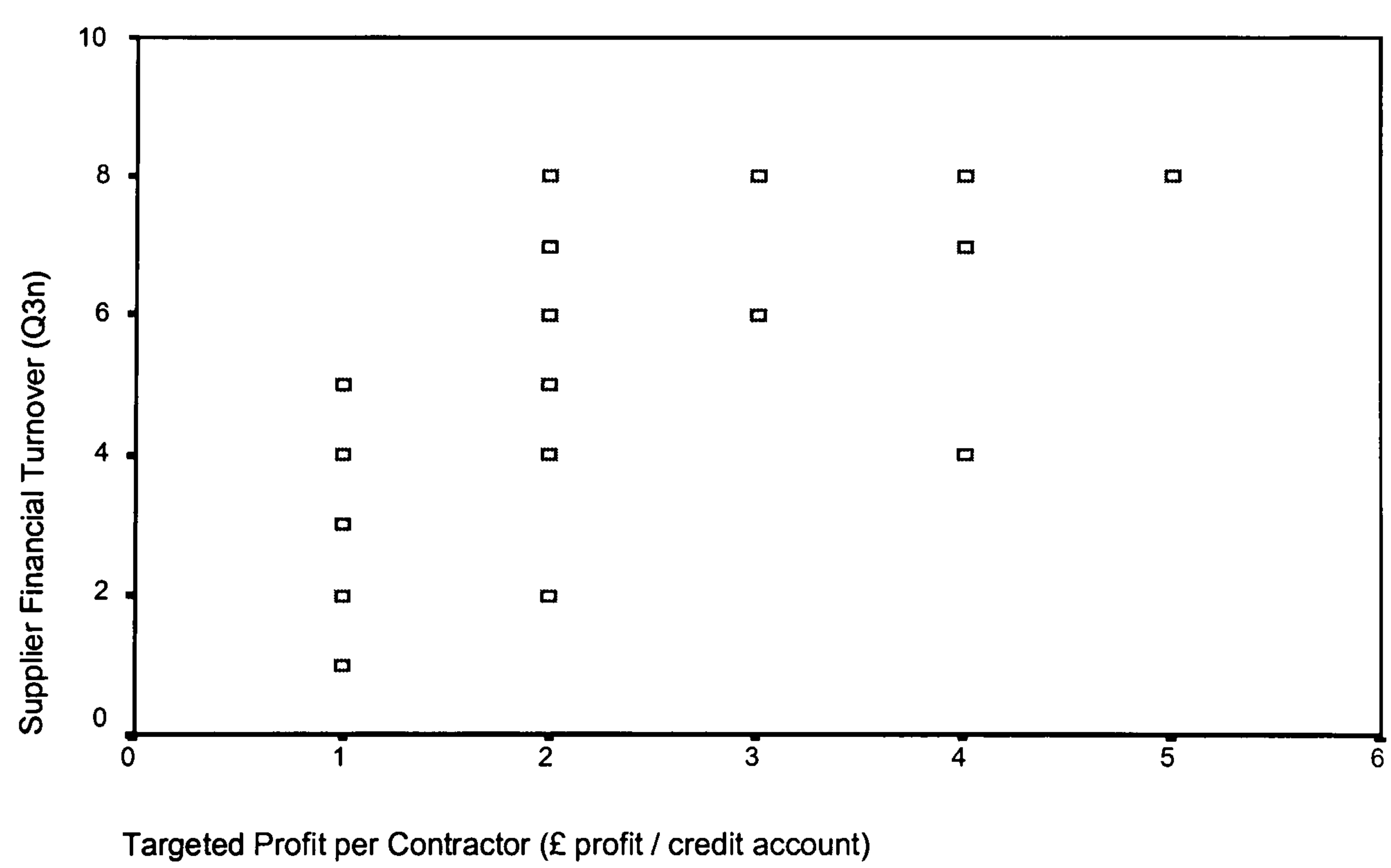
Where suppliers failed to provide certain information the average response rate has been assumed.

Table 8.10
Suppliers' targeted profit (£) to be made from each furnished credit account (=$p£/c^{tr}$)

Targeted Profit	Frequency	Percentage Frequency	MDA Code
£10.63 to £168.00	11	20.0	1
£168.01 to £390.00	12	21.8	2
£390.01 to £765.00	12	21.8	3
£765.01 to £1,487.50	10	18.2	4
£1,487.51 to £3,187.50	10	18.2	5
TOTAL	*55*	*100.0*	

Where suppliers failed to provide certain information the average response rate has been assumed.

Graph 8.1
Supplier turnover versus targeted profit per contractor



Having detailed the dependent variable, MDA statistics along with significant independent variables are now considered. Independent variables, and respective 'codings', are detailed in Appendix 8.4.

8.6.2 Discussion of MDA results associated with suppliers' profit margins

MDA results are shown in Table 8.11 for average profit (£) made per credit account furnished (p£/c^{tr}). The ranked power (descending) order in discriminating for the dependent variable is: annual financial turnover of supplier (Q3N); number of credit accounts furnished (Q5n); methods used to establish credit limits (Q9N); whether suppliers' ask for a guarantee of payment for substantial orders (Q24N); and proportion of supplier turnover that the credit control department 'costs' to operate (Q13N). The order of the variables' discriminating power is obtained from observations in Table 8.11 relating to standardised discriminant function coefficients.

From the eigenvalues in Table 8.11 it is evident that Function 1 is significantly larger than the other functions. This is also confirmed by the cumulative percentage of variance; Function 1 accounts for nearly eighty-seven per cent of total variance. Function 1's canonical correlation supports the conclusions drawn so far, because the figure is closer to one than any of the other functions. A Wilks' Lambda statistic of 0.216 for Function 1 along with the high significance level of the chi-squared statistic reinforces its discriminating power. Function 1 may be used in this context with a high degree of confidence.

Table 8.11
MDA results for predicting targeted profit per furnished credit account ($p£/c^{tr}$)

Canonical Discriminate Function	Eigenvalue	Cumulative Percentage of Variance	Canonical Correlation	Wilks' Lambda	Chi-square
1	2.353	86.80	0.838	0.216	73.565
2	0.276	97.00	0.465	0.724	15.490
3	0.056	99.10	0.230	0.924	3.773
4	0.024	100.00	0.154	0.976	1.156

78.18% of original grouped cases correctly classified

Canonical discriminant function coefficients

Variable	Function			
	1	2	3	4
Q24N	0.470	1.067	1.089	0.487
Q3N	1.174	-0.115	-0.044	0.340
Q5N	-0.725	0.192	0.134	-0.975
Q9N	0.329	0.882	-0.411	-0.204
Q13N	0.169	0.602	-0.374	0.972
Constant	-4.070	-5.710	0.802	-0.161

Standardised canonical discriminant function coefficients

Variable	Function			
	1	2	3	4
Q24N	0.312	0.709	0.723	0.324
Q3N	1.610	-0.158	-0.060	0.467
Q5N	-0.89	0.236	0.164	-0.976
Q9N	0.352	0.946	-0.441	-0.218
Q13N	0.122	0.433	-0.269	0.699

Dependent variable $p£/c^{tr}$

When considering independent discriminating variables in isolation for Function 1, the canonical discriminating coefficient for Q5N (number of credit accounts furnished) is negative. That is, the smaller the number of credit accounts furnished positively contributes towards increased targeted profit. There are many possible reasons for this. First, because of bias in the respondent sample stratification. However, in the knowledge that only five suppliers were placed in the top category of the dependent variable (refer Table 8.9) and, that from the 'prime data' that the discriminant function was based on, there were 18 suppliers with 1,001 or more credit accounts. This proposition can be discarded.

Maybe the result identifies that suppliers who trade with a niche customer base are able to place a greater mark-up on their products, compared to suppliers having a large customer base? Suppliers who do concentrate on a specific customer base can place themselves in a position of considerable risk. If one potential debtor defaults on repayment then this induces a larger loss than if the supplier had spread their potential debt over a larger number of contractors. Increased risk demands that increased levels of reward should be sought i.e. larger targeted profit margins.

Also worthy of consideration is the fact that if suppliers are targeting larger quantities of profit, at an inverse rate to the number of credit accounts they furnish, then they are also turning-over less volume of materials. Handling and distributing of materials induces a cost to the supplier (vehicles, personnel, storage space, security) so an obvious 'saving' can be made from such a strategy. The negative aspect here, is that manufacturers and suppliers are likely to reduce the discounts offered as a result of reduced volume; and costs (savings) relating to economies of scale are to some extent foregone. In the long term therefore, it is questionable whether furnishing fewer credit accounts is good business practice if profit maximisation is the ultimate aim.

Finally, it has been shown that the greater the quantity of credit allowed a contractor, has a direct influence on the supplier's utility from such transaction (Chapter 5). Ultimately, this and the other points needing consideration identify that: (a) suppliers need to quantify the risk they are exposed to and price this accordingly; and (b) research is required to allow suppliers to perform (a) effectively.

Regarding whether suppliers would ask for guarantees of payment should a contractor place a substantial order (Q24N), the positive canonical discriminant function coefficient indicates that to gain maximum profit (from a single contractor's trade), guarantees should always be asked for. This is logical. After all, if suppliers are going to furnish more credit than 'normal', they should have some form of protection to counteract this risk. Because contractors can only obtain such guarantees from other money 'lenders', this suggests that a degree of credit risk should be transferred onto these third parties.

Increasing supplier turnover (Q3N) assists in targeting higher profit margins. This implies that suppliers selling a large quantity of materials should be able to negotiate larger discounts from their suppliers. Hence, 'large' suppliers can achieve a larger mark up on their sales and remain competitive, in contrast to 'smaller' suppliers.

The model fails to pick out one single method for optimising profit with respect to methods used for establishing credit limits (Q9N). Here, it is possible to infer that all credit limit methodologies have a degree of inaccuracy and that when using two or more of the methods simultaneously, this error element is reduced.

The cost of a supplier's credit control department (Q13N) exerts influence upon targeted profit. Departments that account for a 'large' percentage of turnover tend to be associated with larger profit margins. Maybe this is because suppliers with 'expensive' credit control procedures realise the importance of increasing returns on capital employed to keep shareholders interested. Alternatively, these organisations apparently realise the risk they are exposing themselves to and seek appropriate reward.

For the second MDA profit related model, it is found that the (descending) ranked importance order of the discriminating variables for the dependent variable with approximately equal numbers of suppliers in each league (=p£/c^{tr}) are as follows:

i. the geographical region where materials are supplied to (Q2N);
ii. the growth or contraction of suppliers' turnover (Q4EQLSZ);
iii. the method of establishing credit limits for each contractor (Q9N);
iv. the average amount of money spent evaluating a contractor's creditworthiness (Q12O); and
v. whether suppliers' ask for guarantees of payment when a contractor places a substantial order (Q24N) (Table 8.12).

The canonical correlation coefficients imply that suppliers seeking maximum profit per credit account portray the following characteristics:

i. trade on a nation-wide basis;
ii. have had positive financial growth over the last three financial years;
iii. tend to use two or more methods for establishing contractor credit limits;
iv. spend considerable finances evaluating contractor creditworthiness and;
v. never ask for guarantees of payment..

Table 8.12
MDA results for predicting targeted profit per furnished credit account. Equal sized groups (=p£/c^{tr})

Canonical Discriminate Function	Eigenvalue	Cumulative Percentage of Variance	Canonical Correlation	Wilks' Lambda	Chi-square
1	0.606	57.20	0.614	0.418	41.923
2	0.345	89.80	0.507	0.671	19.178
3	0.107	99.90	0.311	0.902	4.946
4	0.001	100.00	0.034	0.999	0.056

50.91% of original grouped cases correctly classified

Canonical discriminant function coefficients

Variable	Function			
	1	2	3	4
Q12O	0.006	0.007	0.004	0.008
Q24N	-0.608	0.775	-0.799	0.328
Q2N	-0.235	-0.069	0.200	0.173
Q4EQLSZ	0.432	-0.492	-0.066	0.284
Q9N	0.438	0.461	0.350	-0.412
Constant	-0.387	-1.155	-0.238	-1.612

Standardised canonical discriminant function coefficients

Variable	Function			
	1	2	3	4
Q12O	0.473	0.532	0.316	0.614
Q24N	-0.396	0.504	-0.52	0.214
Q2N	-0.656	-0.192	0.558	0.483
Q4EQLSZ	0.541	-0.616	-0.082	0.356
Q9N	0.482	0.508	0.386	-0.454

Dependent variable =p£/c^{tr}

Suppliers satisfied with smaller profits from each credit account furnished exhibit opposing characteristics to these.

To confirm this second MDA model's predictive accuracy of 50.91 per cent, the hold-out-sample was correctly classified in six out of ten cases.

8.6.3 Interim conclusion: supplier' profit margins

This section has investigated suppliers' data regarding targeted profit margins, based on characteristics of their credit control and debt collection procedures. MDA failed to produce good discriminating functions when certain dependent variables were considered in isolation. Therefore, a transposed dependent variable was developed which quantified the amount of profit sought (from each contractor furnished with credit). It was found that those suppliers who demanded larger quantities of profit per credit account furnished (for the most accurate MDA model [i.e. not =p/c^{tr}]):

i. always asked for guarantees of payment;
ii. had a 'large' financial turnover;
iii. had a reduced number of credit accounts;
iv. used two or more methods for establishing credit limits; and
v. running costs of their credit control department were relatively high.

In short, 'good' credit control and contractor (risk) evaluation, brings with it reward in the way of profit.

The discriminating variables have identified that those suppliers who have recognised that furnishing credit is risky, and subsequently take precautions to protect themselves from bad debt, have a greater probability of making 'larger' amounts of profit than suppliers who act in a converse manner.

Though the MDA models presented do perform with predicted accuracy, the element of error within them highlights that suppliers' credit control and debt collection procedures fail to show uniformity through the industry. This means that statements regarding contractor creditworthiness evaluation and debt collection procedures being inaccurate, reactive and ad hoc are justified. At present, there appears to be a degree of noise relating to suppliers' credit control and debt collection procedures. This identifies the need for further research in these domains.

8.7 SUMMARY

The findings in this chapter do not uncover the mystic for ensuring continued supplier existence. However, it is hypothesised that should a supplier incorporate the discriminating variables identified in this research and 'support' them with a quality business structure capable of adjusting to market demands, then their existence and prosperity would be significantly greater than had converse actions been undertaken.

The MDA models have all identified key factors of a supplier's credit control and debt collection department that can discriminate one supplier from the next (in relation to the dependent variable being considered). Because supplier organisations are individual and unique in their characteristics, the findings that a department that costs between 0.5 and one per cent of their turnover to operate is interesting to say the least.

To reiterate the findings of this chapter, it has been found that suppliers' financial turnover is associated with:

i. the suppliers' attitude towards insuring themselves against bad debt;
ii. the number of credit accounts furnished;
iii. the percentage of (creditworthy) contractors that have credit limits imposed upon them;
iv. whether guarantees of payment are sought for substantial orders; and

v. the percentage growth or contraction, that a supplier experienced in the last three trading years.

MDA has also identified that suppliers' financial turnover movement is associated with:

i. the supplier's attitude towards insuring against bad debt;
ii. the type of trade the supplier trades with;
iii. the methods used by a supplier to define credit limits for creditworthy contractors;
iv. the UK geographic region that materials are supplied to by the supplier;
v. the amount of bad debt perceived as 'acceptable' by the supplier;
vi. the average time spent by a supplier when evaluating a contractor's creditworthiness;
vii. the percentage turnover per annum suppliers' credit control department costs to operate;
viii. suppliers' standard terms of payment; and
ix. suppliers' percentage of bad debt to sales in last financial year (1997-8).

When considering suppliers' bad debt and the associated MDA model with this variable, the following variables are associated with these factors:

i. whether the supplier has a standard procedure for collection of overdue accounts;

ii. the supplier's attitude towards checking the creditworthiness of contractors' creditworthiness before offering them credit;

iii. the supplier's standard terms of payment for goods offered on credit;

iv. the supplier's attitude towards insuring against bad debt;

v. whether the supplier would ask for guarantees of payment if a substantial order is placed;

vi. the supplier's financial turnover movement from 1995-1998; and

vii. the method the supplier uses to determine the credit limit of creditworthy contractors.

MDA identified that the following characteristics were associated with suppliers' targeted profit margins:

i. whether the supplier would ask for guarantees of payment should a contractor place a substantial order;

ii. the financial turnover of the supplier per annum;

iii. the number of credit accounts that the supplier furnished;

iv. the methods used to establish credit limits of creditworthy contractors;

v. the cost of the supplier's credit control department;

vi. the UK geographic region that materials were supplied to;

vii. the amount of money spent evaluating a potential debtor's creditworthiness; and

viii. the financial turnover movement of the supplier from 1995-1998.

Having summarised the salient issues and findings of the MDA analysis, the following chapter concludes this thesis and suggests potential areas for future research.

CHAPTER 9

CONCLUSIONS, RECOMMENDATIONS AND FURTHER RESEARCH

9.1 CONCLUSIONS

Regardless of the nature of materials that suppliers supply to the construction industry, there is a need for them to use accurate contractor creditworthiness evaluation procedures. Fundamentally, this is because the accuracy of suppliers' credit control and debt collection procedures has a direct link with their prosperity and hence survival. Furthermore, because the majority of suppliers' financial turnover is accounted for by credit sales, the decision to grant credit (or not), is of paramount importance not only for suppliers, but contractors alike.

At present (2000), research has shown that suppliers methods for evaluating the creditworthiness of potential debtors tends to be ad hoc, bespoke and reactive (Chapter 2). Further, suppliers themselves perceive the accuracy of their present credit control and debt collection procedures as having an accuracy no greater then 'average' (Chapter 7).

Suppliers are key organisations within the construction supply chain (Proverbs and Holt, 2000). This is because they provide contractors with a form of working capital, that allows them to tender for and complete construction projects well beyond the scope of their own financial resources (op.cit.).

Present failings of methods used for determining the creditworthiness of, and credit limits for, potential debtors can be categorised under three main headings:

i. the reactive, ad hoc and bespoke nature of evaluation measures;

ii. the isolated nature between the financial standing of the lending institute and the potential debtor's borrowing requirements. That is, regardless of the size of the supplier's financial turnover and / or the amount of credit that the contractor wants, the credit risk is perceived as impacting to equal extent on the supplier. And;

iii. the failure of present creditworthiness evaluation methods to agree on a consensus credit limit figure for a potential debtor.

These three factors justify this research into this particular aspect of the supplier / contractor financial relationship. To develop, and take the knowledge domain further, an alternative contractor creditworthiness evaluation procedure was constructed. This evaluation procedure encompassed the following stages of development:

i. identification of present literature that had an influence upon the supplier / contractor relationship;

ii. construction of a conceptual creditworthiness evaluation model;

iii. investigation of variables included in (ii.);

iv. based on research findings in (iii.) specific consideration was given to suppliers' utility influences from granting credit;

v. investigation of present methods used by suppliers' credit control and debt collection departments; and

vi. hypothetical and 'real life' model testing of factors influencing suppliers' utility achieved from granting credit.

Due to contractor creditworthiness evaluation having received minimal prior consideration, this thesis provides a significant inroad into the subject's knowledge domain. This statement is made in the knowledge that eight academic publications have been achieved from this research at time of submitting this thesis for examination, whilst another three papers are currently in the refereeing process. Further, many of the referees' comments received from submitting papers to journals indicated that the subject under consideration was worthy of research resources due to its rigour and novelty.

Considering each of the stages of the research that were undertaken in greater detail, the following observations and conclusions are made.

9.1.1 Identification of literature that had an influence upon the supplier / contractor business relationship

The reviewed literature identified that very little previous research had been conducted into the business relationship between creditor and debtor. When considering the 'wider' business environment and its participants, a similar conclusion was also drawn. Predominantly, research had concentrated on the prediction of organisation insolvency. This is rather than determining the amount of money that a potential debtor is 'justifiably' allowed to borrow.

The literature review identified:

i. the inadequacies of present creditworthiness evaluation methods;

ii. a number of variables that needed to be considered in any supplier / contractor financial business relationship; and

iii. factors that needed to be considered in a structured survey of suppliers' credit control and debt collection procedures.

Based on these, the respective observations were included in subsequent work conducted.

9.1.2 Construction of a conceptual creditworthiness evaluation model

Leading on from the literature review, a conceptual contractor creditworthiness model was derived (Formula 3.3). The model took into consideration both supplier and contractor characteristics that have an influence upon these organisations' business relationship. The model consisted of the following generic variables:

i. *Cr*: the degree of creditworthiness and associated influence upon the supplier's utility achieved from granting credit;

ii. *C*: the financial characteristics of the contractor that have influence on their ability to repay a debt;

iii. *E*: the macroeconomic business environment;

iv. *M*: the managerial decision making characteristics of both interacting organisations;

v. *D*: the quantity of credit that the debtor wants to be allowed on credit, the associated efficiency of the supplier's debt collection procedures; and

vi. *e*: the error correction variable.

Because the literature review had identified that the business environment and interacting organisations' decision-making traits were key factors influencing credit risk, specific subsequent research was conducted into these aspects.

9.1.2 Specific investigation of variables *E* and *M*

Regression analysis identified that the four point centred moving average of insolvency levels of English and Welsh construction contractors could be modelled and predicted by using the following 'raw' data and their respective transformations:

i. the four point centred moving average of brick deliveries for the UK;
ii. the differencing[1] by four quarters of a year data relating to the UK construction materials price index for housing;
iii. the sand and gravel deliveries, for the UK, differenced by one quarter of a year; and
iv. lagging sand and gravel deliveries, made to UK construction sites, by one quarter of a year.

The variables listed are in descending order of their ability to model the dependent variable i.e. variable *E* of the conceptual model.

When considering variable *M* of the conceptual model, three key areas of previous research were identified as having an influence upon the decision-making

[1] *Differencing is observing the difference between one time period and the next and continuing this process until the required number of differences are achieved (see chapter 4 Figure 4.7)*

characteristics of the supplier and contractor's business relationship. These three areas and respective number of sub variables were:

i. the supplier / contractor business relationship (6 variables);
ii. the supplier and contractors' decision-making characteristics (5 variables); and
iii. the managerial personnel of the supplier's and contractor's organisation that have an influence upon the supplier and contractor's business relationship (14 variables).

These three sections of variable M (Formula 3.3) were then modelled using utility theory. This allowed the model to be dynamic and take into account the individual perceptions of different suppliers.

A common theme was observed from the research that had been conducted to this point. This was that crediting organisations had to perceive the risk of offering a contractor credit as 'worthwhile'. That is, suppliers had to perceive themselves as gaining in utility for the risk that they exposed themselves to. Because of this recurring utility observation a model was used to determine the factors influencing utility achieved by a supplier when offering a contractor credit. The model identified that suppliers' utility from such an interaction is influenced by:

i. the profit the supplier will make from allowing the contractor credit. The greater the profit margin, the greater the utility experienced. As the targeted profit margin is reduced, so the supplier experiences a hyperbolic loss in utility;

ii. the probability of the debtor defaulting upon repayment. The greater the probability of bad debt, the greater the loss in utility is. As the probability of bad debt increases there is a linear loss in utility gained;

iii. the quantity of finances the debtor wants (credit limit) to be allowed. The greater the credit amount, the greater the credit risk and potential utility loss via a hyperbolic function; and

iv. a supplier's financial asset base against which bad debt could be counteracted with. The greater this resource, the reduced negative influence on utility achieved from an interaction.

To gain greater knowledge regarding *Cr* and *D* of the conceptual model, as well as the factors that have an influence on suppliers' utility, a UK nation wide structured survey of suppliers' credit control and debt collection procedures was conducted. The survey found out what methods suppliers used to evaluate potential debtors and how credit limits for these organisations were set. Pertinent questions in the survey asked suppliers how they perceived the accuracy of the present methods they employed in evaluating credit risk and collecting debt.

9.1.3 Investigation of methods used by suppliers' credit control and debt collection departments

Suppliers who complied with the following criteria were surveyed to gain information on their credit control and debt collection practices and how accurate they perceived these methods:

i. had been in business for five or more years;

ii. had a minimum annual financial turnover of £½m;

iii. supplied construction materials *only* to the industry;

iv. 'advertised' in the Kompass directory; and

v. were members of one or more of the following institutes: Builders Merchants Federation; Institute of Builders Merchants; and / or the Institute of Logistics.

A total of 55 completed questionnaires were returned from the 375 dispatched.

Information gained from the survey indicated:

i. supplying materials to the industry was a potentially profitable activity: average financial turnover growth was 5.85 per cent between 1995 and 1998, whilst average targeted profit margin was 8.57 per cent;

ii. credit sales tended to dominate suppliers' financial turnover: average credit sales to turnover ratio was 70.77 per cent;

iii. credit limits for potential debtors tended to be set based on the business relationship between the supplier and contractor;

iv. suppliers assigned minimum resources to evaluating a contractor's creditworthiness (typically less than £50 and under 1 hour per evaluation);

v. few suppliers (37.74 per cent) offer discounts as a persuasive force for debtors to make repayments on time;

vi. the majority tended not to insure (88.89 per cent do not insure) or use factors (98.15 per cent do not factor debt) for protection against bad debt;

vii. suppliers reassessed debtors' creditworthiness on an ad hoc basis, based predominantly (66.67 per cent) on an *'if and when the need arises'* basis .

9.1.4 Investigation of factors influencing suppliers': financial turnover; profit and bad debt

Multivariate discriminate analysis (MDA) was used to identify discriminating characteristics to investigate specific variables that had an influence on *Cr* and *D* of Formula 3.3, and which also had an impact upon the utility that suppliers received from granting credit. Using an independent sample of ten suppliers, and applying their credit control and debt collection departments' characteristics to the derived MDA functions the models were validated. This is because similarities were observed between the number of suppliers correctly classified by the hold out sample and the original sample of suppliers that the MDA model was constructed from.

For the MDA analysis using supplier's financial turnover as the dependent variable it was found that the following variables were associated with this:

i. the number of credit accounts the supplier furnishes (nominally classified);
ii. the percentage of contractors who have credit limits imposed on them (nominally classified);
iii. whether suppliers would ask for guarantees of payment should a contractor place a substantial order (nominally and Z score classified);
iv. the percentage of financial turnover movement the supplier experiences between 1995-1998 (nominally and Z score classified);
v. whether suppliers insure against bad debt, or not (nominally classified); and
vi. the number of credit accounts the supplier furnishes (ordinally classified).

These variables are listed in their descending order of discriminating power for the dependent variable.

For suppliers' compounded financial turnover movement between 1995 and 1998, (when segregating the dependent variable into equal band widths, based on the range of survey responses gathered) the following variables were found to discriminate best:

i. the maximum amount of bad debt suppliers' perceive as 'acceptable' (ordinally classified);
ii. the methods suppliers use to establish credit limits for potential debtors (nominally classified);
iii. the UK geographic region that the supplier supplies materials to (nominally classified);
iv. the type of trade the supplier supplies materials to (nominally classified); and
v. whether the supplier insures against bad debt, or not (nominally classified).

These variables are listed in their descending order of discriminating power for the dependent variable.

When conducting an MDA and segregating the range of suppliers' financial turnover movement into groups with an approximately equal number of suppliers in each, the following variables discriminate best:

i. the percentage of suppliers' turnover that it costs to operate their credit control department (nominally classified);

ii. the suppliers' standard terms of payment that they impose on creditworthy contractors (nominally classified);

iii. the average time the supplier spends evaluating a potential debtor's creditworthiness (nominally classified);

iv. the percentage of bad debt that the supplier incurred in financial year 1997-8 (ordinally classified);

v. the construction trade that the supplier supplies materials to (nominally classified); and

vi. the UK geographic region that the supplier supplies materials to.

Once again, these variables are listed in their descending order of discriminating power for the dependent variable.

When discriminating for the percentage of bad debt that suppliers' incurred in financial year 1997-8, the following factors were identified as being associated with this variable:

i. whether the supplier has a standard procedure for collecting bad debt, or not (nominally classified); and

ii. the supplier's attitude to checking the creditworthiness of potential debtors before granting them credit (nominally classified).

Once, again the variables are described in descending discriminating importance power.

When investigating the discriminating variables for suppliers' targeted profit margins (minus bad debt incurred), the following variables were identified:

i. the method the supplier uses to establish credit limits of potential debtors (nominally classified);
ii. the financial turnover of the supplier in 1997-1998 (nominally classified);
iii. the suppliers' attitude towards insuring against bad debt, or not (nominally classified);
iv. the terms of payment that the supplier imposes onto potential debtors (nominally classified); and
v. whether the supplier would ask for guarantees of payment should a contractor place a substantial order (nominally categorised).

These variables are listed in their descending order of discriminating importance for the dependent variable.

The MDA analysis regarding the targeted profit per credit account furnished indicated that the following variables were able to discriminate for the dependent variable:

i. the annual financial turnover of the supplier in 1997-1998 (nominally classified);

ii. the number of credit accounts that the supplier furnished in 1997-1998 (nominally classified);

iii. the method that the supplier uses to establish credit limits for potential debtors (nominally classified);

iv. whether the supplier would ask for guarantees of payment should a contractor place a substantial order (nominally classified); and

v. the percentage of suppliers' turnover that their credit control department costs to operate (nominally classified).

These variables are listed in their descending order of discriminating importance for the dependent variable.

Because the dependent variable in the previous described MDA had a significant proportion of the total observations in one league, a complementary MDA was constructed. This alternative analysis segregated the dependent variable into leagues with an approximately equal number of observations in each. The following variables were identified as best discriminators:

i. the UK geographical region that materials were supplied to (nominally categorised);

ii. the compounded financial turnover movement of suppliers from 1995-1998 (nominally categorised);

iii. the method the supplier uses to establish credit limits for potential debtors (nominally categorised);

iv. the average amount of money a supplier spends evaluating a potential debtor's creditworthiness (ordinally categorised); and

v. suppliers' attitude towards asking for guarantees of payment if a contractor placed a substantial order (nominally categorised).

These variables are listed in their descending order of discriminating importance for the dependent variable.

In summary, the results obtained using MDA had allowed greater insight to be gained into elements *Cr* and *D* of the conceptual model (Formula 3.3).

As a conclusion to the research, the contents of this thesis provide a solid grounding upon which future work could build. That is, the foundations have been laid; future research needs to build on them.

9.2 RECOMMENDATIONS AND FURTHER RESEARCH

The process of defining the credit risk that a contractor imposes onto a supplier when granted credit needs to be known. This knowledge could indicate to suppliers whether the risk involved in the business transaction is worthwhile, or not. The research contained in this thesis has identified a number of avenues for future research.

The following points provide recommendations for further research:

- Suppliers need to be educated to use ratio analysis as a means of gaining an insight into the financial characteristics of potential and actual debtors.
- Suppliers need to realise that eliminating bad debt is not always the best line of action if company financial growth is desired.
- Suppliers need to maximise their available resources and have clear organisational goals, which all departments can aim to achieve.
- Suppliers need to realise that they are of vital importance to the construction industry. Because of this, suppliers should invest in research to allow them to understand *what* they are doing and *why*.

The following points suggest areas for future research:

- Variables identified in the conceptual model, along with their respective sub-variables need to be weighted to indicate which are more important than others in determining credit risk.
- Because the decision to grant credit (or not) is highly individualistic, research into what factors contribute towards suppliers' risk taking characteristics needs to be identified.
- Because, in general, suppliers and contractors operate on a 'lowest tender / materials price basis', there is a need to consider what would happen if partnering between contractors and suppliers became the 'norm'. Inevitably a shift would occur from lowest price to 'better' business relationships. However, would this shift be so great that contractors would inform the supplier of an imminent ability of not being able to meet a debt repayment?

- Suppliers need to realise that for any creditworthiness evaluation model to operate 'correctly' it can only do so if the input data is correct. If the input data is wrong, then the wrong result will be gained. Suppliers need to have a well-grounded knowledge of the variables they need to observe to correctly analyse the risk associated with granting a contractor credit.

In summary, what the conclusions, recommendations and points for further research indicate is that there remains a significant void in the knowledge domain when trying to evaluate a potential debtor's actions when furnished credit. The research contained in this thesis has gone some way to analysing the creditor / debtor relationship. Inevitably, because the construction industry is now concerned more than ever with lean supply and achieving its clients' objectives, the research domain into the financial relationship between contractors and their materials suppliers looks set to grow in the foreseeable future.

References

Abdullah, R.Z. and Taylor, A.H. (1989) Meeting the Problem of Cost Control Systems. CIOB.

Abidali, A. F. (1990) A Model for Predicting Company Failure in the Construction Industry. PhD Thesis, Loughborough University.

Abidali, A. F. and Harris, F. C. (1995) A Methodology for Predicting Company Failure in the Construction Industry. Construction Management and Economics 13 (3) 189-196.

Agapiou, A. Clausen, L. E. Flanagan, R. Norman, G. and Notman, D. (1998a) The Role of Logistics in the Materials Flow Control Process. Construction Management and Economics 16 (2) 131-137.

Agapiou, A. Flanagan, R. Norman, G. and Notman, D. (1998b) The Changing Role of Builders Merchants in the Construction Supply Chain. Construction Management and Economics. 16 (3) 351 – 361.

Akintola, A. and Sommerville, J. (1995) Distributed Lag Relationships between UK Construction Orders and Output. Construction Management and Economics 13 (1) 33-42.

Akintoye, A. (1995) Just-In-Time Application and Implementation for Building Materials Management. Construction Management and Economics 13 (2) 105-113.

Akintoye, S. A. & Skitmore, R. M. (1994) A Comparative Analysis of Three Macro Price Forecasting Models. Construction Management and Economics. 12, 257-270

Alreck, P. L. and Settle, R. B. (1995) The Survey Research Handbook; Second edition. IRWIN.

Altman, E. I. (1968) Financial Ratios, Discriminate Analysis and Prediction of Corporate Bankruptcy. Journal of Finance 23 (4), 89 - 610.

Altman, E. I. (1976) The Z Score Bankruptcy Model; Post, Present and Future. IN Institutions and Markets in a Fragile Environment. eds Altman EI and Sametz AW. John Wiley and sons Inc.

Altman, E. I. (1983) Predicting Corporate Bankruptcy: the Z-Score Model. In: Corporate Financial Distress: A Complete Guide to Predicting, Avoiding and Dealing with Bankruptcy. John Wiley and Sons Inc., New York.

Altman, E. I. (1993) Corporate Financial Distress and Bankruptcy. Second Edition. John Wiley & Sons, Inc.

Altman, E. I. And Sametz, A. W. (1977) Financial Crises. Institutions and Markets in a Fragile Environment: John Wiley and Sons.

Altman, E. I. Avery, R. B. Eisenbeis, R. A. and Sinkey, Jr J. F. (1981) Application of Classification Techniques in Business Banking and Finance. JAI Press Inc. Greenwhich, Conneticut.

Altman, E.I., The Z Score Bankruptcy Model; Post, Present and Future. IN Institutions and Markets in a Fragile Environment. Eds. Altman, E.I. and Sametz, A.W. John Wiley and Sons Inc. 1976.

Anderson, C. and Paine, F. T. (1975) Managerial Perceptions and Strategic Behaviour. Academy of Management Journal 18, 811-823.

Annual Abstract of Statistics, HMSO. 1972, 1974, 1976, 1978, 1980, 1982, 1984, 1986, 1988, 1990, 1992, 1994, 1996, 1998.

Anon (1998) http://www.atkearney.com/about/press/111698.html

Banwell, G. H. (1964) The Placing and Management of Contracts for Building and Civil Engineering Work. HMSO.

Barr, C. (1996) Fear Not: the Art of Risk Communication. Journal of Management in Engineering. January / February 1996 p.18-22.

Barrie, G. (1998) Pay-when-paid outlawed. Building, 15 May 1998 p.7.

Bathory, A. (1987). The Analysis of Credit: McGraw-Hill.

Begg, D. Fisher, S. and Dornbushel, R. (1991) Economics 3rd Edition. McGraw-Hill International (UK) Ltd.

Bell. G.D. (1989) Financial Management in Construction. CIOB.

Berggren, C. (1993) Changing Buyer-Supplier Relationships in the Australian Automotive Industry – Innovative Partnerships or Intensified Control. Centre for Corporate Change, University of South Wales.

Bernoulli, D. (1738) Exposition of a New Theory on the Measurement of Risk. Reprinted in Econometrica, XXII: 23-36 (January 1954).

Black, J. and Bradley, J. F. (1990) Essential Mathematical for Economists. Second Edition. John Wiley and Sons.

Brandon, P. S. (1999) Transferring Research into Practice 'Engagement leading to Enactment' RICS Construction and Building Research Conference, 1-2 September 1999 University of Salford.

Brett, M. (1991) Beginners Guide; When Cash Flow Means More Than Profit. Estates Gazette 9 November 1991.

Brett, M. (1992) Beginners Guide; Credit Enhancement and Securitisation. Estates Gazette 22 Feb 1992

Briscoe, G. (1992). The Economics of the Construction Industry: Batsford.

Brook, R. C. and Arnold, G. C. (1985) Applied Regression Analysis and Experimental Design. Marcel Dekker Inc. New York and Basel.

Burgelman, R. (1983) A Model of the Interaction of Strategic Behaviour, Corporate Context and the Concept of Strategy. Academy of Management Review, 12, 38-51

Burt, D. N. (1989) managing Suppliers up to Speed. Harvard Business Review (4) 127-135.

Carey, M. (Unknown) Credit Risk in Private Debt Portfolios. Papers and Proceedings: Fifty-Eighth Annual Meeting, American Finance Association.

Central Statistics Office (1998). Annual Abstract of Statistics: HMSO.

Chatterjee, S. and Price, B., Regression Analysis By Example. John Wiley & Sons. 1977.

Checkland, P. (1981) Systems Thinking, Systems Practice. John Wiley and Sons, Chichester. ISBN 0 471 27911 0

Chevin, D. (1993) Perfect Pitch, in Building 4 June.

Chinyio, E. A. Olomolaiye, P. O. Kometa, S. T. and Harris, F. C. (1998) A Needs-Based Methodology for Classifying Construction Clients and Selecting Contractors. Construction Management and Economics 16 (1) 91-98.

Coleshaw, J. (1989). Credit Analysis. How to Measure and Manage Credit Risk: Woodhead-Faulkner Ltd.

Construction Industry Institute (1987) Project Materials Handbook. Bureau of Engineering Research: University of Texas at Austin.

Daly, F. Hand, D. J. Jones, M. C. Lunn, A. D. and McConway, K. J. (1995) Elements of Statistics. The Open University, Addison Wesley Publishing Company.

Deakin, E. B. (1976) Business Failure Prediction: An empirical Analysis. IN Institutions and Markets in a Fragile Environment. eds Altman EI and Sametz AW. John Wiley and sons Inc.

Deming, W. E. (1986) Out of Crisis. Cambridge University Press.

Drury, A. C. (1982) Finance Houses: Their Development and Role in the Modern Financial Sector. Waterlow Publishers.

Drury, C. (1993) Costing: an Introduction. Second Edition. Chapman & Hall.

Edum-Fotwe, F. Price, A. and Thorpe, A. (1996) A Review of Financial Ratio Tools for Predicting Contractor Insolvency. Construction Management and Economics 14 (3) 189-198.

Egan, Sir John (1998) Rethinking Construction. The report of the Construction Task Force to the Deputy Prime Minister, John Prescott, on the scope of improving quality and efficiency of UK construction. Department of Environment, Transport and the Regions, 16 July 1998.

Emmerson, H. (1962) Survey of Problems before the Construction Industries. Report prepared for Minister of Works by Sir Harold Emmerson. HMSO.

Erlandson, D. A. Harris, E. L. Skipper, B. L. and Allen, S. D. (1993) Doing Naturalistic Inquiry. A Guide to Methods. Sage Publication, International Educational and Professional Publisher. Newbury Park, California. ISBN 0-8039-4938-3

Fadel, H. and Parkinson, J. M. (1978) Liquidity Evaluation by Means of Ratio Analysis. Accounting and Business Research, Spring 101-107.

Fellows, R. (1996) Monte Carlo Simulation of Construction Costs Using Subjective Data. Construction Management and Economics 14 (5) 457-460.

Fellows, R. F. (1990) Construction in the Economy. CE2 – Construction Project Economics, University of Bath.

Ferguson, M. F. Peters, S. R. (1995) What Constitutes Evidence of Discrimination in Lending? Journal of Finance June 1995 v50 n2 p739(10)

Financial Times (1999) 24 May 1999.

Frankfort-Nachmias, C. and Nachmias, D. (1996) Research Methods in the Social Sciences. Fifth Edition. Arnold St. Martin's Press, Inc.

Frees, W. E., Data Analysis Using Regression Models; The Business Perspective. Prentice Hall. 1996.

Goddard, W.E. (1986) Just-in-Time: Surviving by Breaking Through Tradition. Oliver Wright Limited Publications.

Godddard S and Jay S (1980) Medium Sized Companies and the Cash Discount Trap. Accountancy 1980 Feb p. 135 - 7

Goldstein, M. and Dillon, W. R. (1978) Discrete Discriminant Analysis. John Wiley & Sons.

Goodman, R. E. and Chinowsky, P. S. (1997) Preparing Construction Professionals for Executive Decision Making. Journal of Management in Engineering. 13 (6) 55-61.

Grant, W. H. and Schlesinger, L. A. (1995) Realize Your Customers' Full Profit Potential. Harvard Business Review Article. Product Number 95503.

Hambrick, D. C. and Mason, P. (1984) Upper Echelons: The Organisation as a Reflection of its Top Managers. Academy of Management Review, 9, pp.193-206

Hancock, M. and Gale, A. W. (1992). The Burden of Systems Theory - An Inappropriate Construct for Democracy in Building. Paper given at the

Association of Researchers in Construction Management Conference in the Isle of Man.

Hand, D. J. (1981) Discrimination and Classification. John Wiley & Sons.

Handy, C. (1991) The Age of Unreason, 2nd Edition. Mackays of Cheltenham.

Handy, C. (1993) Understanding Organisations. Fourth Edition . Penguin.

Harré, R and Gillett, G. (1994) The Discursive Mind. Sage Publications.

Hatush, Z and Skitmore, M. (1997a) Evaluating Contractor Prequalification Data: Selection criteria and Project Success Factors. Construction Management and Economics 15 (2) 129-147.

Hatush, Z. and Skitmore, M. (1997b) Criteria for Contractor Selection. Construction Management and Economics 15 (1) 19-38.

Haverstock, H (Unknown) Contractor's Insolvency. Easibrief 26.

Hedberg, B.L.T. Nysrtom, P. and Starbuck, W.H. (1976) Camping on Seesaws: Prescriptions for a Self-Designed Organisation. Administrative Science Quarterly, 21, pp.41-65.

Heller, F. A. (1976) Decision Process: An Analysis of Power Sharing at Senior Orgainisational Levels. In Dubin, R. (ed) Handbook of Work, Organisation and Society. Chicago Rand, McNally.

Hillebrandt, P. M. & Cannon, J. (1994). The Modern Construction Firm. MacMilan Press London.

Hillebrandt, P. M. (1971). Small Firms in the Construction Industry. Committee of Inquiry on Small Firms Research report No. 10. HMSO.

Hillebrandt, P. M. (1974) Economic Theory and the Construction Industry. Macmillan London.

Hillebrandt, P. M. (1984). Analysis of the British Construction Industry. MacMillan Publishers London.

Hillebrandt, P. M. Cannon, J. & Lansley, P. (1995). The Construction Company In and Out of Recession. MacMillan Press London.

Holt, G. D. (1995) A Methodology for Predicting the Performance of Construction Contractors. Unpublished PhD thesis, University of Wolverhampton.

Holt, G. D. (1996) Applying Cluster Analysis to Construction Contractor Classification. Building and Environment, Vol. 31, No.6, pp.557-568.

Holt, G. D. (1997) Classifying Construction Contractors: A case study using cluster analysis. Building Research and Information, Vol. 25 No. 6 pp.374-382.

Holt, G. D. (1998) A Guide to Successful Dissertation Study for Students of the Built Environment. Second Edition. Built Environment Research Unit, University of Wolverhampton. ISBN 1-902010-01-9.

Holt, G. D. Olomolaiye, P. O. and Harris, F. C. (1994) Applying Multi-Attribute Analysis to Contractor Selection Decisions. European Journal of Purchasing and Supply Management Vol. 1 No.3 pp.139-148.

Holt, G. D. Olomolaiye, P. O. and Harris, F. C. (1994) Applying Multi-attribute Analysis to Contractor Selection Decisions. European Journal of Purchasing and Supply Management, Vol. 1 No. 3, pp. 139-148.

Holt, G. D. Olomolaiye, P. O. and Harris, F. C. (1994) Factors Influencing UK Construction Clients' Choice of Contractor. Building and Environment, 29 (2) 241-248.

Holt, G. D. Olomoliaiye, P. O. & Harris, F. C. (1994) Evaluating Prequalification Criteria in Contractor Selection. Building and Environment Vol 29 No.4 437 - 448.

Holt. G. D. Love, P. E. D. and Li. H. (2000). The Learning Organisation: Towards a Paradigm for Mutually Beneficial Strategic Construction Alliances. The International Journal of Project Management. Oxford: Elsevier Science Ltd. In Press and scheduled for: Vol. 18, No. 6. ISSN: 0263-7863.

Horvath, R. M. and McMillan, C. J. (1979) Strategic Choice and the Structure of Decision Processes. International Studies of Management and Organisation 9, pp.87-112.

Housing and Construction Statistics, HMSO. 1972, 1974, 1976, 1978, 1980, 1982, 1984, 1986, 1988, 1990, 1992, 1994, 1996, 1998

Housing Grants, Construction and Regeneration Act 1996. (1996) HMSO.

Huberty, C. J. (1994) Applied Discriminant Analysis. Wiley-Interscience Publication. New York. ISBN 0-471-31145-6.

Hutson, T.G. & Butterworth, J. (1984). Management of Trade Credit. Third Edition: Gower.

Janis, I. L. (1982) Groupthink, 2nd edition. Boston: Houghton Mifflin.

Janis, I. L. (1985) Sources of Error in Strategic Decision-Making. In J. M. Pennings (ed.) Organisational Strategy and Change. San Francisco: Jossey-Bass, pp.157-197.

Jarillo, J. C. (1995) Strategic Networks. Creating the Borderless Organization. Butterworth Heinemann.

Jaselski, E. J. and Russell, J. S. (1992) Risk Analysis Approach to Selection of Contractor Evaluation Method. Construction Engineering and Management, 118 (4) 814-821.

Jennings, P. and Holt, G. D. (1998) Prequalification and Multi-Criteria Selection: A Measure of Contractors' Opinions. Construction Management and Economics 16 (6) 651-660.

Kaka AP & Price ADF (1993) Modelling Standard Cost Commitment Curves for Contractors' Cash Flow Forecasting. Construction Management and Economics 11 (4) 271 – 283.

Kaka, A. P. (1994) Contractors' Financial Budgeting Using Computer Simulation. Construction Management and Economics 12 (2) 113-124.

Kaka, A. P. and Price, A. D. F. (1991) Net Cash Flow Models: Are They Reliable? Construction Management and Economics 9 (3) 291-308.

Kale, S. and Arditi, D. (1999) Age-dependent Business Failure in the US Construction Industry. Construction Management and Economics 17 (4) 493-503.

Kangari, R., Farid, F. and Elgharib, H.M. (1992). Financial Performance Analysis for Construction Industry. Journal of Construction Engineering and Management 118 (2), 349 –361

Kast, F. E. and Rosenzweig, J.E. (1985). Orgainzation and Management – A Systems and Contingence Approach (4th edition): McGraw-Hill.

Kenley, R. and Wilson, O. D. (1989) A Construction Project Net Cash Flow Model. Construction Management and Economics 7 (1) 3-18.

Kirkman, P. R. A. (1973) Function and future of liquidity ratios. Accountancy May 1973 p 26 - 33.

Kirkman, P. R. A. (1974). Credit Control and Debt Collection. A Brief Guide to Current Practice: British Institute of Management.

Klecka, W. R. (1987) Discriminant Analysis. Series in Quantitative Applications in the Social Sciences. Sage University Paper.

Klein, R. (1998) Builder, Hold Onto Pay-When-Certified Clauses at Your Peril. Building 10 July 1998 p.29.

Kometa, S. T. and Olomolaiye, P. O. (1997) Evaluation of Factors Influencing Construction Clients' Decision to Build. Journal of Management in Engineering 13 (2) 77-86.

Kometa, S. T. Olomolaiye, P. O. and Harris, F. C. (1996) Validation of the Model for Evaluating Client-Gendered Risk by Project Consultants. Construction Management and Economics 14 (2) 131-145.

Kompass Company Information (1996 and 1997) Reed Business Information.

Koopman, P. L. (1983) Communinicatie en overleg bij afbouw. M&O, Tijdschrift voor Organisatiekunde en Sociaal Beleid, 37, 48-68

Lachenbruch, P. A. and Goldstein, M. (1979) Discriminant Analysis. Biometrics. 35 (1) 69-85.

Langford, D. Hancock, M. R. Fellows, R. and Gale, A. W. (1995) Human Resources Management in Construction. Longman Scientific and Technical. ISBN 0-582-09033-4.

Langford, D. Iyagba, R. and Komba, D.M. (1993). Prediction of Solvency in Construction Companies. Construction Management and Economics 11 (5), 317 – 325

Latham, M (1994) Constructing The Team. HMSO.

Lipsey, R. G. (1989) An Introduction to Positive Economics. 7th Edition. Harper & Row.

Loosemore, M. (1995) Reactive Management: Communication and Behavioural Issues in Dealing With the Occurrence of Client Risks. Construction Management and Economics 13 (1) 65-80.

Lowe, J. (1997) Insolvency in the UK Construction Industry. Journal of Financial Management of Property and Construction. 2 (1), pp.83-110.

Lowe, J. G. (1987) Monopoly and the Materials Supply Industries of the UK. Construction Management and Economics 5 (1) 57-71.

MacCrimmon, K. R. and Taylor, R. N. (1976) Decision Making and Problem Solving. In Dunnette, M. D. (ed) Handbook of Industrial Organisational Psychology. Chicago Rand. McNally.

Mak, S. W. (1995) Risk Analysis in Construction: A Paradigm Shift From a Hard to Soft Approach. Construction Management and Economics 13 (5) 385-392.

Manley, B. F. J. (1991) Multi-variative Statistical Methods: A Primer. Chapman Hall.

March, J. G. and Simon, H. A. (1958) Organisations. New York: Wiley.

Mason, R. J. and Harris, F. C. (1979) Predicting Company Failure in the Construction Industry. Proceedings of Institution of Civil Engineers, 66, 301-7.

Meddis, R. (1984) Statistics using Ranks: A Unified Approach. Basil Blackwell Publisher Ltd.

Miles, R and Snow, C (1978) Organisational Strategy, Structure and Process. New York: McGraw Hill

Ming, C. S. Runeson, G. and Sktimore, M. (1996) Changes in Profit as Market Conditions Change: A Historical Study of A Building Firm. Construction Management and Economics 14 (3) 253-264.

Mintzberg, H. (1983) Structure in Fives. Prentice-Hall.

Murdoch, J. and Hughes, W. (1996) Construction Contracts Law and Management. Second Edition.: E & F Spon.

Muya, M. Price, A. D. F. and Thorpe, A. (1997) Construction Materials Supply Logistics. ARCOM 13th Annual Conference and AGM. 15-17th September 1997 Kings College Cambridge.

Nash, J. (1996). A Sense of Perspective. The GTI Careers Journal Construction and Building Services. 1996 Edition 7 p.4

Navon, R. (1995) Resource-Based Model for Automatic Cash-Flow. Construction Management and Economics 13 (6) 501-510.

Navon, R. (1996) Company-level Cash-Flow Management. Journal of Construction Engineering and Management. 122 (1) pp.22-29.

Ng, C. K. Smith, J. K. Smith, R. L. (1999) Evidence on the Determinants of Credit Terms used in Interfirm Trade. Journal of Finance June 1999 v54 i3 p1109(2).

Ng, S. T. and Smith, N. J. (1998) Verification and Validation of Case-Based Prequalification System. Journal of Computing in Civil Engineering 12 (4) 215-226.

Nicholas, J. Holt, G. D. and Harris, P. T. (1998) Financial Business Relationships: A Conceptual Model for Evaluating Contractors' Creditworthiness. Journal of Financial Management of Property and Construction 3 (3) 17-35.

Nicholas, J. and Holt, G. D. (1999) Construction Materials Suppliers: To trade or not to trade? That is the question. RICS Construction and Building Research Conference, University of Salford 1-2 September 1999. Vol 1. pp.60-67.

Nicholas, J. Holt, G. D. and Harris, P. T. (2000a) Suppliers' Debt Collection and Contractor Creditworthiness Evaluation. In press Building Research and

Information: The International Journal of Research, Development, Demonstration and Innovation.

Nicholas, J. Holt, G. D. Harris, P. T. and Minsein, M. (2000b) A Conceptual Risk Assessment Model for Evaluating Construction Contractors' Creditworthiness. Being refereed.

Nicholas, J. Holt, G. D. and Minsein, M. (2000c) Forecasting Construction Materials Suppliers' Financial Turnover. In press Engineering, Construction and Architectural Management.

Nicholas, J. Holt, G. D. and Harris, P. T. (2000d) Materials Suppliers: the Builders' Banker. In press Journal of Financial Management of Property and Construction.

Nicholas, J. Holt, G. D. and Minsein, M. (2000e) Contractor Financial Credit Limits: Their Derivation and Implications for Materials Suppliers. In press Construction Management and Economics.

Nicholas, J. Holt, G. D. and Harris, P. T. (2000f) Construction Contractor Insolvency Levels: Macroeconomic Influences. Being refereed.

Nicholas, J. Holt, G. D. and Harris, P. T. (2000g) Risk Analysis of Contractors' Trade: Predicting Materials Suppliers' Profit Margins. Being refereed.

Nicholas, J. Holt, G. D. and Mihsein, M. (2000h) Predicting Materials Suppliers' Bad Debt. Being refereed.

Nicholas, J. Holt. G. D. and Love, P. E. D. (2000i) Influences on Construction Materials Suppliers' Financial Turnover. In press European Journal of Purchasing and Supply.

Norušis, M. J. (1985) SPSS^{X} Advanced Statistics Guide. McGraw-Hill Book Company. ISBN 0-07-046548-7.

Norušis, M. J. (1993) SPSS Professional Statistics 6.1. SPSS Inc. ISBN 0-13-190127-7

Novack, J. (1995) The Coming Fight Over FICO. Forbes Dec 18, 1995 v156 n14 p96(1)

Office for National Statistics (1999) Retail Price Index Department. Tel: 0171 533 5874.

Ofori, G. (1994) Establishing Construction Economics as an Academic Discipline. Construction Management and Economics. 12 (4), 295 - 306.

Oltman, D. O. and Lackritz, J. L. (1991). Statistics for Business and Economics: Brooks Cole.

Oxford Advanced Learner's Dictionary (1995) Editor Crowther, J. Oxford University Press. ISBN 0-19-431422-7.

Peters, T. J. & Waterman, R. H. (1989). In Search of Excellence lessons from America's Best-Run Companies. Harper and Row, Publishers London.

Peters. T. (1988) Thriving On Chaos. Handbook for a Management Revolution. Macmillan London.

Philips, J. (1977) Business Credit – a practical guide to its everyday management. Financial Techniques Limited. Working Surrey.

Pike, R. and Neale, B. (1999) Corporate Finance and Investment. Decisions and Strategies Third Edition. Prentice Hall Europe.

Pilcher, R. (1992) Principles of Construction Management. Third Edition. McGraw-Hill International Series in Civil Engineering.

Pool, J. Koopman, P.L. and Kamerbeek, E. (1986) Veranderingsprocessen bij de rijksoverheid: Cases en keuzemomentem. M&O, Tijdschrift voor Organisatiekunde en Sociaal Beleid, 40, 516-531

Popper, K. R. (1959) The Logic of Scientific Discovery: London Hutchinson.

Proverbs, D. G., Holt G. D. (1999). Reducing construction costs: implications on the supply chain based on European best practice. European Journal of Purchasing and Supply Management. Special edition: Construction supply chain management. BEING REFEREED

Punwani, A. (1997) A Study of the Growth-Investment-Financing Nexus of the Major UK Construction Groups. Construction Management and Economics 15 (4) 349-361.

Ranasinghe, M. (1996) Total Project Cost: A Simplified Model for Decision Makers. Construction Management and Economics 14 (6) 497-505.

Ranasinghe, M. and Russell, A. D. (1992a) Analytical Approach for Economic Risk Quantification of large Engineering Projects: Validation. Construction Management and Economics 10 (X) 45-68.

Raven, B. (1973) Towards Profitable Credit Control. Accountancy. August 1973 pp.10 - 15

Rees, B. (1990) Financial Analysis. Prentice Hall.

Robbins, S. P. (1991) Organisational Behaviour: Concepts, Controversies, and Applications. Fifth Edition. Prentice Hall International Editions.

Rouse, N. (1991) Bankers' Lending Techniques. The Chartered Institute of Bankers.

Russell, A. D. and Ranasinge, M. (1992) Analytical Approach for Economic Risk Quantification of Large Engineering Projects: Validation. Construction Management and Economics 10, 277-301.

Russell, A. D. and Ranasinge, M. (1992) Analytical Approach for Economic Risk Quantification of Large Engineering Projects: Validation. Construction Management and Economics 10 277-301.

Russell, J. S. (1992). Decision Models for Analysis and Evaluation of Construction Contractors. Constriction Management and Economics 10 (3), 185 – 202

RusselL, J. S. (1996) Constructor Prequalification: Choosing the Best Constructor and Avoiding Constructor Failure. New York, ASCE Press.

Russell, J. S. (1996) Predicting Contractor Failure Using Stochastic Dynamics of Economic and Financial Variables. ASCE Vol 122 No.2 June

Russell, J. S. and Jaselski, E. J. (1992) Predicting Construction Contractor Failure Prior to Contract Award. Construction Engineering and Management, 118 (4) 791-811.

Russell, J. S. and Zhai, H. (1996) Predicting Contractor Failure Using Stochastic Dynamics of Economic and Financial Variables. Journal of Construction Engineering and Management. 122 (2) 183 – 191

Russell, J. S. and Zhai, H. (1996). Predicting Contractor Failure using Stochastic Dynamics of Economic and Financial Variables. Journal of Construction Engineering and Management 122 (2), 183-191.

Russell, J. S. Hancher, D. E. & Skibniewski, M. J. (1992) Contractor Prequalification for Construction Owners. Construction Management and Economics.

Russell, J. S. Hancher, D. E. and Skibniewski, M. J. (1992) Contractor Prequalification Data for Construction Owners. Construction Management and Economics 10 (2) 117-135.

Russell, J. S., Hancher, D. E. and Skibniewski, M. J. (1992). Contractor Prequalification Data for Construction Owners. Construction Management and Economics 10 (2), 117 - 129.

Rutter, D. K. (1993) Construction Economics; is there such a thing? CIOB.

Sako, M. (1992) Prices, Quality and Trust: Inter-firm Relations in Britain and Japan. Cambridge University Press.

Sandras Jr. W. A. (1989) Just-In-Time: Making it Happen. Unleashing the Power of Continuous Improvement. Oliver Wright Publications.

Schwartz, R. A. (1974) An Economic Model of Trade Credit. Journal of Financial and Quantitative Analysis. 9, 643-657.

Severson, G. D. Jaselskis, E. J. and Russell, J. S. (1993) Trends in Construction Contractor Financial Data. Journal of Construction Engineering and Management 119 (4) 854-858.

Severson, G.D., Russell, J.S. and Jaselskis, E.J. (1994). Predicting Construction Contractor Surety Bonds Claims using Contractor Financial Data. Journal of Construction Engineering and Management 120 (2), 405 - 420.

Shirazi, B. Langford, D. A. and Rowlinson, S. M. (1996) Organisational Structures in the Construction Industry. Construction Management and Economics 14 (3) 199-212.

Shrivastaa, P. and Grant, J. H. (1985) Empirically Derived Models of Strategic Decision-Making Processes. Strategic Management Review, 6, 97-113

Simister SJ (1994) Usage and Benefits of Project Risk Analysis and Management. International Journal of Project Management.

Simon, E, (1942) The Placing and Management of Building Contracts. HMSO.

Sizer J (1989) An Insight Into Management Accounting. Penguin

Skitmore, M. (1992) Parameter Prediction for Cash Flow Forecasting Models. Construction Management and Economics 10 (5) 397-413.

Skitmore, R. M. and Marsden, D. E. (1988) Which Procurement System? Towards a Universal Procurement Selection Technique. Construction Management and Economics. 6 (1) 71-89.

Sloman, J. (1994) Economics 2nd edition. Prentice Hall

Smith K V (1974) Management of Working Capital. West publishing Co

Smith, D. (1998) Lean Firms Abandon Growth in Pursuit of Big Profits. Sunday Times Business Section 15 November 1998 p.2

Smith, J. K. (1987) Trade Credit and Informational Asymmetry. The Journal of Finance. XLII (4) pp.863-872.

Srinivasan, V. and Kim, Y. H. (1987) Credit Granting: A Comparative Analysis of Classification Procedures. Journal of Finance. XLII (3) pp.665-683.

Stein, J. (1981) Contextual Factors in the Selection of Strategic Decision Methods. Human Relations, 34, 819-834

Stern, J. (1999) Why Debt Really Doesn't Give More Value Than Equity. Sunday Times Business Section 23 May 1999.

Stuttaford, J. C. (1991a). Will the Client Pay? Credit checking. Architects Journal 27 March 1991

Stuttaford, J. C. (1991b) Will the client pay? Credit Agencies. A J 3 April 1991

Sunday Times Newspaper (1997) Business Section p.4. 31 August 1997.

Taffler, R. J. (1983) The Z-Score Approach to Measuring Company Solvency. The Accountant's Magazine, March, 91-6.

Taffler, R. J. (1995) The Use of the Z-Score Approach in Practice. Centre for Empirical Research in Finance and Accounting; City University Business School. Working Paper 95/1

Tah, J. H. M. Thorpe, A. and McCaffer, R. (1994) A Survey of Indirect Cost Estimating in Practice. Construction Management and Economics 12 (1) 31-36.

Talaga, J and Buch. J. Credit Practices of European Subsidiaries of U.S.

Multinational Corporations.

Tam, C. M. and Harris, F. C. (1996) Model for Assessing Building Contractors' Project Performance. Engineering, Construction and Architectural Management. 3 (3) 187-203.

Tavakoli, A. and Kakalia, A. (1993) MMS: A Materials Management System. Construction Management and Economics 11 (2) 143-149.

Tiong, R. L. K. (1993) Strategies in Risk Management of On-Demand Guarantees. Journal of Construction Engineering and Management, 118 (2) 229-243.

Tucker, S. N. and Rahilly, M. (1988) A Construction Cash Flow Model. Australian Institute of Building Papers, 3 pp.87-99.

Uff, J. (1994) Construction Law Fifth Edition. Sweet and Maxwell.

Uher, T. E. (1994) A General Risk Classification Model. Australian Institute of Building Papers. 5 pp.25-33.

Winch, G. (1998) The Growth of Self-Employed in British Construction. Construction Management and Economics 16 (5) 531-542.

Wong, E. T. and Norman, G. (1997) Economic Evaluation of Materials Planning Systems for Construction. Construction Management and Economics 15 (1) 39-47.

Woodward, J. (1980) Industrial Organisation: Theory and Practice second Edition Oxford University Press.

Bibliography

Agarwal, V. and Taffler, R. (1999) Tell-tale Signs of Companies about to Fail. Sunday Times Business Section 25 April.

Agresti, A. (1990) Categorical Data Analysis. John Wiley and Sons.

Al-Tabtabai H & Diekmann JE (1992) Judgmental Forecasting in Construction Projects. Construction Management and Economics. 10 19 - 30.

Anon (1992) Engineers and Risk Issues; Code of Professional Practice. HSE and Lloyds Register.

Aqua Group () Contract Administration for the Building Team. Blackwell Science

Asakawa, K and Takagi, H (1994) Neural Networks in Japan. Communications of the ACM 37 (3) 106-112.

Atkinson, A. C. (1987) Plots, Transformations and Regression. An Introduction to Graphical Methods of Diagnostic Regression Analysis. Oxford Science Publications.

Baumol, W. J. (1977) Economic Theory and Operations Analysis. Fourth Edition. Prentice Hall International Series in Management. ISBN 0-13-227132-X.

Berthoud, R and Kempson, E (1992) Credit and Debt. The PSI Report. Policy Studies Institute, London.

Bingham T (1990) Pay Direct Clauses Save An Architect From A Bloody Nose. Builder 16 November

Bingham T (1991) When the Zero Option is to Liquidate a Debtor. Building 25 Jan 1991

Bingham T (1996) Simple Trust Funds are Best. Building 26 April 1996

Birkes, D. and Dodge, Y. (1993) Alternative Methods of Regression. Wiley Clasic Library.

Birrell, G. S. (1988) Bid Appraisal Incorporating Past Performance by Contractors. American Association of Cost Engineers. Trans. D1. 1-D1.6.

Bond, S. and Meghir, C. (1994) Dynamic Investment Models and the Firm's Financial Policy. Review of Economic Studies. 61 pp.197-222.

Brooks, D. (1988) Accounting Requirements - Standards and Legislation. CIOB

Buckley, A. Ross, S. A. Westerfiled, R. W. and Jaffe, J. F. (1998) Corporate Finance Europe. McGraw Hill.

Burgelman, R. (1983) A Model of the Interaction of Strategic Behaviour, Corporate Context and the Concept of Strategy. Academy of Management Review, 12, 38-51

Burnett, R.G. (1991) Insolvency and the Sub-Contractors. CIOB

Cannon J (1994) Lies and Construction Statistics. Construction Management and Economics 1994 12 307 - 313.

Carey, M. (Unknown) Credit Risk in Private Debt Portfolios. Papers and Proceedings: Fifty-Eighth Annual Meeting, American Finance Association.

Chapman, C.B. (1990) A Risk Engineering Approach to Project Risk Management. Project Management.

Chiang, A. C. (1984) Fundamental Methods of Mathematical Economics. Third Edition. MCGraw Hill. ISBN 0-07-010813-7

Coles, M. (1998) Are You Too Soft to be a Manager? Sunday Times Appointments Section 13 December 1998.

Cook, D. R. and Weisberg, S. (1986) Residuals and Influence in Regression. Chapman Hall.

Crichton S & Ferrier C (1986). Understanding Factoring and Trade Credit. Waterlow's Business Library.

Crosslin, R. L. (1991) Decision-Support Methodology for Planning and Evaluating Public-Private Partnerships. Journal of Urban Planning and Development. 117 (1) 15-31.

Davies, L. and Ledington, P. (1991) Information in Action. Soft Systems Methodology. Macmillan London. ISBN 0-333-56539-8.

Davis, E. W. and Yeomans, K. A. (1974) Company Finance and The Capital Market; A Study of the Effects of Firm Size. Cambridge University Press Occasional Paper 39.

Dewhurst, J. and Burns, P. (1992) Small Business Planning, Finance and Control. Second Edition. MacMillan.

Diekman. J. E. (1981) Cost Plus Contractor Selection; a Case Study. Journal of the Technical Councils, American Society of Civil Engineers 107 (TC1) 13-25.

Drew, S. and Skitmore, R. M. (1992) Competitiveness in Bidding; a Consultant's Perspective. Construction Management and Economics, 10 (3) 227-247.

Duncan, R. B. (1972) Characteristics of Organisational Environments and Perceived Environmental Uncertainty. Administrative Science Quarterly 17, 313-327

Erlandson, D. A. Harris, E. L. Skipper, B. L. and Allen, S. D. (1993) Doing Naturalistic Inquiry. A Guide to Methods. Sage Publication, International Educational and Professional Publisher. Newbury Park, California. ISBN 0-8039-4938-3

Evans, N. (1995) Using Questionnaires and Surveys to Boost Your Business. The Institute of Management. Pitman Publishing.

Fairweather, V. (1993) Going International: Profit or Peril? Worldwide Projects 1 (1) 6-10.

Ferguson, M. F. Peters, S. R. (1995) What Constitutes Evidence of Discrimination in Lending? Journal of Finance June 1995 v50 n2 p739(10)

Financial Management, Spring 1996 v25 n1 p71(15)

Financial Times (1999) 24 May 1999.

Fisher, J. (1982) When the Damage is Financial. Building 8 October 1982 p 37-8

Flanagan, R. and Norman, G. (1982) Making Good Use of Low Bids. Chartered Quantity Surveyor, March 226-227.

Fleet, T. (1992) Legal Arguments - Protecting Against Employer Insolvency. Building 13 November.

Forman, M. and Gilbert, J. (1976) Factoring and Finance. Heinemann Accountancy and Administration Series.

Fox, J. (1991) Regression Diagnostics: An Introduction. Sage University Paper Series on Quantitative Applications in the Social Sciences, 07-079.

Frederick, C. S. (1989) Modern Working Capital management. Text and Cases. Prentice Hall International Editions.

Furnham, A. and Lewis, A. (1986) The Economic Mind. The Psychology of Economic Behaviour. Harvester Press.

Gardner, N. (1998) Cut Your Debt Before Lenders Turn Nasty. The Sunday Times Money Section 25 October 1998.

Graham, P. (1984/85) Insolvencies. Quantity Surveyors Practice Pamphlet No.5. RICS.

Grant, W. H. and Schlesinger, L. A. (1995) Realize Your Customers' Full Profit Potential. Harvard Business Review Article. Product Number 95503.

Greene, W. H. Econometric Analysis. Maxwell Macmillan International Editions. New York. ISBN 0-02-946457-9.

Hamilton, K. (1998) Aggregate and Tarmac Discuss £1.4bn Merger. Sunday Times Business Section 1998.

Hamilton, K. and Waples, J. (1998) Investors Press for Tarmac deal. Sunday Times Business Section 20th December 1998 p.2.

Hanscombe, R. (1976) Bankers' Management Handbook. McGraw Hill.

Harper, D. R. (1971) Evaluation of Alternative Methods of Contractor Selection. UMIST Conference, International Building.

Harvey, J. (1993) Modern Economics Sixth Edition. The Macmillan Press Ltd.

Higson, C. (1995) Business Finance; Second Edition. Butterworths.

Hill, D. (1998) Banks Tell Customers: Check Your Credit Files. Money Section p.1 The Sunday Times 15 March 1998.

Hill, J. (1993) Law Change Gives Employers More Options. CSW 11 Feb.

Hill, S. (1989) Managerial Economics: The Analysis of Business Decisions. MacMillan. ISBN 0-333-39864-5.

Hill, S. (1989) Managerial Economics: The Analysis of Business Decisions. Macmillan London. ISBN 0-333-39864-5.

Huberty, C. J. (1994) Applied Discriminant Analysis. Wiley-Interscience Publication. New York. ISBN 0-471-31145-6.

Hutchinson N and Nanthakumaran N (1994) Applications of Discounted Cash Flow Techniques. Estate Gazette June 4 194

Hutton, W (1996) The State We're In. New and Revised Edition. Vintage.

Kangari, R. and Riggs, L. S. (1988) Portfolio Management in Construction. Construction Management and Economics 1988, 6, 161 - 169

Karen, L. R. (1974) An Introduction to Behaviour Theory and its Application. Harper's Experimental Psychology Series.

Kinnear, P. R. and Gray, C. D. (1995) SPSS/PC+ Made Simple. Lawrence Erlbaum Associates.

Kirkman, P. R. A. (1977) Modern Credit Management. George Allen & Unwin Ltd.

Kirkman, P. R. A. (1973) Function and future of liquidity ratios. Accountancy May 1973 p 26 - 33.

Kirkman, P. R. A. (1974). Credit Control and Debt Collection. A Brief Guide to Current Practice: British Institute of Management.

Kirkman, P. R. A. (1977) Modern Credit Management: A Study if the Management of Trade Credit under Inflationary Conditions. George Allen & Unwin.

Kirkman, P. R. A. (1977) Modern Credit Management: A Study of the Management of Trade Credit Under Inflationary Conditions. George Allen & Unwin.

Krishnaiah, P. R. (1973) Multivariate Analysis – III. Proceedings of the Third International Symposium on Multivariate Analysis Held at Wright State Unioversity, Dayton, Ohio, June 19 – 24, 1972. Academic Press.

Lamden, B. (1993) Law Change Gives Employers More Options. CSW 11 Feb.

Lardaro, L (1993) Applied Econometrics. Harper Collins College Publishers. ISBN 0-06-043847-9.

Liska, R. W. and Snell, B. (1993) Financial Incentives programs for Average-Size Construction Firm. Journal of Construction Engineering and Management 118 (4) 667-676.

Lloyd H () Creditors' Right for Compensation. Building?

Macneil J (1996) Chance Meeting. Building

Maital, S. (1988) Novelty, Comfort and Pleasure: Inside the Utility –Function Black Box. In Psychological Foundations of Economic Behaviour. Edited by Albanese, P. J. Praeger Publishers

Management International Review, Feb 1992 v32 n2 p149(14)

Management Today, Jan 1995 p52(3)

Manser, J. E. (1994) Economics a foundation course for the built environment. E & F Spon

McKenna, E. (1994) Business Psychology & Organisational Behaviour: A Students' Handbook. Lawrencee Erlbaum Associates, USA.

McQueen, J. (1990) Going Bust The Insolvency Laws. A.J. 31 October.

McWilliams, J. D. Discussion. IN Institutions and markets in a fragile environment. eds Altman EI and Sametz AW. John Wiley and sons Inc.

Merna, A. and Smith, N. J. (1990) Bid Evaluation for UK Public Sector Construction Contracts. Proceedings of the Institution of Civil Engineers, Part 1, Pt. 1, 91-105.

Morris, A (1991) Getting the Priorities Right. Chartered Quantity Surveyor.

Morris, S. and Shin, H. S. (1999) Co-ordination Risk and the Price of Debt.

New Directions in Economic Psychology. Theory, Experiment and Application Edited by Lea, S. E. G. Webley, P. and Young, B. M. (1992) Edward Elgar Publishing Limited.

Novack, J. (1995) The Coming Fight Over FICO. Forbes Dec 18, 1995 v156 n14 p96(1)

Parris J () Default by sub-contractors and suppliers

Petersen, M. A. and Rajan, R. G. (1997) Trade Credit: Theories and Evidence. The Review of Financial Studies. 10 (3) pp.661-691.

Philips, J. (1977) Business Credit – a practical guide to its everyday management. Financial Techniques Limited. Working Surrey.

Powell M (1993) The Choice Between Trust and Distrust in Building CIOB

Powell-Smith V (1983) Liquidated Damages. AJ 5 October 1983

Powell-Smith V (1984) Contractor Insolvency. AJ 7 March 1984

Powell-Smith V (1984) Interest Payments on Contractors Claims AJ

Preece, C. Male, S. (1997) Promotional Literature for Competitive Advantage in UK Construction Firms. Construction Management and Economics 15 (1) 59-69.

Rayburn, L. (1986) Contractor, Businessman. Civil Engineering ASCE 56 (7) 51-53.

Ren H & Lin SS (1996) The UK construction industry under cyclical high inflation, high interest rates and recession. International journal of project management.

Ridout, G. (1996) Chance is a Fine Thing. Procurement

Rosenfeld, Y & Warszawski, A. (1993) Forecasting Methodology of National Demand For Construction Labour. Construction Management and Economics Vol 11 No.1 p18-29.

Rosseau, J.J. (1982) The confessions of Jean-Lacues Rousseau. Translated and with introduction by J.M. Cohen. Penguin Books.

Runeson, K. G. (1988) Methodology and Method for Price-level Forecasting in the Building Industry. Construction Management and Economics Vol 6 No.1 p 49-55.

Scherr, F. C. (1989) Modern Working Capital Management: Text and Cases. Prentice Hall International Editions.

Sebestyén G (1994) A Bulletin of Statistics; Some Considerations. Construction Management and Economics 1994 12 p.373 - 375.

Seymour, D. and Rooke, J. (1995) The Culture of the Industry and the Culture of Research. Construction Management and Economics 13 (6) 511-523.

Sharma, S. (1996) Applied Multivariate Techniques. John Wiley and Sons, Inc. New York. ISBN 0-471-31064-6.

Shash, A. A. and Abdul-Hadi, N. H. (1993) The Effect of Contractor Size on Mark-Up Decision In Sadi Arabia. Construction Management and Economics. 11 (6) 421- 429.

Shi, J. J. (1999) Mathematical Models for Maximising Aggregate Plant Production. Journal of Construction Engineering and Management, 125 (1) 53-60.

Simister SJ (1994) Usage and Benefits of Project Risk Analysis and Management. International Journal of Project Management.

Skinner, B. F. (1972) Beyond Freedom and Dignity. Jonathan Cape Ltd.

Smith K V (1974) Management of Working Capital. West publishing Co

Smith, D. (1998) Emergency Surgery: What does Alan Greenspan know what we don't? Sunday Times Business Section 18 October 1998.

Stewart, R. W. and Fortune, J. () Application of systems Thinking To The Identification, Avoidance and Prevention of Risk.

Swash, A. H. (Unknown) Credit Control: A Practical Guide for Industrial and Commercial Companies. First Edition. Shaws Linton Publications Ltd. ISBN 0906653010.

Talaga, J and Buch. J. Credit Practices of European Subsidiaries of U.S. Multinational Corporations.

Tavakoli, A. and Kakalia, A. (1993) MMS: A Materials Management System. Construction Management and Economics 11 (2) 143-149.

Taylor, R.G. and Bowen, P.A. (1987) Building Price Level Forecasting: an Examination of Techniques and Applications. Construction Management and Economics Vol 5 No1 p21-44.

The Banker, Nov 1994 v144 n825 p90(3)

The Chartered Institute of Building (1993) Marketing. CIOB.

The CIRIA UK Construction Information Guide (1989) E & F Spon.

The Economist (US), Feb 28, 1998 v346 n8057 p79(2)

The Economist (US), Feb 28, 1998 v346 n8057 p80(1)

The Economist (US), June 28, 1997 n9 pS15(2)

The Economist (US), June 28, 1997 n9 pS6(2)

The Economist, (1993) No small change. April 10, v327 n7806 pI18 (4).

The Economist, April 10, 1993 v327 n7806 pI18(4)

The Economist, April 10, 1993 v327 n7806 pI18(4)

The McKinsey Quarterly, Spring 1993 n2 p93(14)

Thompson, J. D. (1967) Organisations in Action. New York: McGraw Hill

UK Economic Accounts 1998: fourth quarter (1998) Office of National Statistics.

Wake J (1996) Credit Management and the Risk of Client Failure. CSM October 1996

Walters, A. A. (1970) An Introduction to Econometrics. Second Edition. MacMillan.

Waples, J. (1998) CRH Joins the Battle for Ailing Tarmac. Sunday Times Business Section 15 November 1998 p.2.

Waples, J. (1998) Simms in Hot Seat as Tarmac Merger Fails. Sunday Times Business Section 20th December 1998 p.8.

Waples, J. and Hamilton, K. (1998) Tarmac to Merge with Aggregate. Sunday Times Business Section 13 December 1998.

Ward, S. C. and Chapman, C. B. (1991) Extending the Use of Risk Analysis in Project Management. Project Management. May 1991.

Warr, P. B. (1980) The springs of action in Chapman, A.J. & Jones, D. M. eds Models of Man. The British Psychology Society.

Watts, B. K. R. (1992) Business and Financial Management. Sixth Edition. The M & E Handbook Series.

Wenner M D. (1995) Group Credit: a Means to Improve Information Transfer and Loan Repayment Performance. Journal of Development Studies Dec 1995 v32 n2 p263(19)

Weston, J. F. and Copeland, T. E. (1989) Managerial Finance Second Edition. Adapted by Fox, A. F. and Limmack, R. J. Cassell.

Weyer, M. V. (1995) Gearing Down. (UK commercial borrowing) Management Today, Jan 1995 (3) p52

Weyer, M. V. Gearing Down. (UK commercial borrowing)

Wheelwright, S. C. & Makridakis, S. (1980) Forecasting Methods for Management. 3rd Edition. John Wiley and Sons.

Wonnacott, R. J. and Wonnacott, T. H. (1970) Econometrics. John Wiley and Sons. ISBN 471 95960 X.

Wuffli, P. A. Hunt, D. A. Fixing the Credit Problem. The New World of Financial Services

Appendix 6.1
Questionnaire to Materials Suppliers

CONSTRUCTION MATERIALS SUPPLIERS QUESTIONNAIRE

This questionnaire is for academic research purposes only.

1. **Please tick the box(es) opposite the classification(s) that best represent the type of contractors your organisation supplies materials to.**

Roofing and insulation contractors........ ☐
Plumbing, heating, ventilation contractors........ ☐
Electrical contractors........ ☐
Ground work contractors........ ☐ [Tick box(es)]
General building contractors........ ☐
Painting and Decorating contractors........ ☐
Specialist contractors e.g. acoustic engineers, lift engineers etc. .... ☐
Other, please state ______________________

2. **Please tick the box(es) next to the region(s) where contractors you supply materials to are located.**

Nation-wide........ ☐	Home Counties........ ☐	
Scotland........ ☐	Midlands........ ☐	
Ireland .... ☐	North East........ ☐	[Tick box(es)]
Wales........ ☐	North West........ ☐	
South West........ ☐	East........ ☐	

3. **Please tick the box next to the category that best represents the total sales turnover of your organisation in the last financial year**

Up to £½ million........ ☐
Over £½ million and under £1 million........ ☐
Over £1 million and under £2 million........ ☐
Over £2 million and under £6 million........ ☐ [Tick box]
Over £6 million and under £12 million........ ☐
Over £12 million and under £16 million........ ☐
Over £16 million and under £25 million........ ☐
Over £25 million and over........ ☐

4. **Please indicate the percentage growth / contraction in sales turnover your organisation has experienced over the last three financial years. Denote growth with a '+' and contraction '-' prior to the percentage figure e.g. 6% growth = +6%.**

Financial Year		
1997-8	1996-7	1995-6

5. **Please tick the category that best represents the number of credit accounts your organisation had with contractors in the last financial year**

1 – 50........ ☐	301– 500........ ☐	
50 – 100........ ☐	501 –1,000........ ☐	[Tick box]
101– 300........ ☐	1,001 and over........ ☐	

6. What proportion of your total sales is accounted for by contractors using credit offered?

0 – 10% .... ☐
10.1 – 20% .... ☐
20.1 – 30% .... ☐
30.1 – 40% .... ☐
40.1 - 50% .... ☐
50.1 – 60% .... ☐
60.1 – 70% .... ☐
70.1 – 80% .... ☐
80.1 – 90% .... ☐
90.1 – 100%........................ ☐

[Tick box]

7. Do you check on the creditworthiness of contractors before granting them credit?

Yes, always.................... ☐
Yes, sometimes............. ☐
No.................................. ☐
If sometimes, when does this apply? ______________________________

[Tick box]

8. What percentage of those contractors allowed credit, do you establish credit limits for?

None.............................. ☐
1 – 20% .... ☐
20.1 – 40% .... ☐
40.1 – 60% .... ☐
60.1 – 80% .... ☐
80.1 – 100%........................ ☐

[Tick box]

9. How do you establish the credit limit for each contractor?

From credit registers or organisations e.g. Dun and Bradstreet...................... ☐
From Bank supplied information .... ☐
Based on duration of relationship between the organisations......................... ☐
Other, please state ____

[Tick box]

10. What sources and methods do you use for checking the creditworthiness of contractors? Please tick the appropriate box.

In the ranked accuracy column identify the source / method that you find most effective. 1 = first choice, 2 = second choice etc. For example, if you consider a Bankers reference as first priority, and its accuracy as being average then this is indicated as shown in the table. Your second choice evaluation procedure should be identified by 2 and third by 3 and so on.

Please remember to tick the appropriate box regarding your perception as to how accurate each source / method is for evaluating contractors' creditworthiness.

Source / method	Ranked accuracy	How accurate do you consider this source / method?		
		Poor	Average	Good
Example: Bankers reference	*1*		✓	
Altman's Z score				
Altman's ZETA model				
Bankers reference				
Contact with company concerned				
Credit registers e.g. Dun and Bradstreet, ACS etc.				
Other sources e.g. report from salesmen				
Ratio analysis				
Trade reference				
Your trade protection association				
Other, please specify				
None				

11. How much time on average (operative hours) does your company spend evaluating each contractor's creditworthiness?

0 – 1 hour .... ☐
1.01 - 3 hours...................... ☐
3.01 – 6 hours..................... ☐
6.01 – 12 hours......................... ☐
Over 12.01 hours...................... ☐ [Tick box]

12. How much money (on average) does your company spend when evaluating a contractor's creditworthiness? (you should include costs of employee's time and overhead costs)

Under £20.......................... ☐
£21 - £50 .... ☐
£51 - £100 .... ☐
£101 - £200 .... ☐
£201- £400 .... ☐ [Tick box]
Over £400................................. ☐

13. Do you have a separate credit control department? If yes, what does this department cost your organisation in terms of percentage turnover per annum? Costs should include overheads, stationary, expenses, training etc.

Under 0.5% .... ☐
0.51 – 1% .... ☐
1.01 – 2% .... ☐
2.01 – 3% .... ☐
3.01 – 4% .... ☐
4.01 – 5% .... ☐ [Tick box]
5% and over.............................. ☐

14. What are your organisation's standard terms of payment?

Thirty days .... ☐
End of month after delivery.. ☐ [Tick box]
End of month of delivery... ☐
Other, please state ______________________________

15. Does your organisation offer discounts for prompt payment?

Yes..................................... ☐ [Tick box]
No...................................... ☐
If Yes, what are the terms of this discount, please state ____________________

____

16. What was the percentage of bad debt to sales in your last financial year?

Under 1% .... ☐
1.01 and under 2%............. ☐
2.01 and under 3%............. ☐
3.01 and under 4%.................... ☐
4.01 and under 5%.................... ☐ [Tick box]
5.01% and over......................... ☐

17. What percentage profit do you aim to make before bad debt is allowed for?

Under 2% .... ☐
2.01 – 4% .... ☐
4.01 – 6% .... ☐
6.01 – 8% .... ☐
8.01 – 10% .... ☐
10.01– 12.5%............................ ☐ [Tick box]
12.51– 15%............................... ☐
15% and over............................ ☐

18. Do you have a standard procedure for collecting overdue accounts?

Yes....................................... ☐
No.. ☐ [Tick box]
If No go to question 19

If yes what procedure is used?

Procedure used	Action taken (tick boxes)	No. of times used in last financial year	After how many days overdue	Debtor's normal response to action taken (tick box)		
				Good	Average	Poor
Further statements						
Reminding letter						
Contact by salesman						
Telephoned by credit department						
Visited by credit department						
Account taken to collection agency						
Trade protection association						
Summons issued by credit section						
Summons issued by legal department						
Summons issued by solicitor						
Court action						

Other, please state ____

19. Do you insure against bad debt?

Yes...☐
No..☐ [Tick box(es)]
If yes is your policy:

A specific debt policy..☐
A whole turnover policy...☐
If whole turnover, for what percentage of debts are you insured?

Under 75% ....☐ 85.1 – 95% ....☐
75.1 – 85% ....☐ 95.1 – 100%..................☐

20. Do you factor any or all of your debts?

Yes................................☐ [Tick box]
No.................................☐
If yes what percentage of the face value of the debt does the factor pay at once?

Under 75% ....☐ 85.1 – 95% ....☐
75.1 – 85% ....☐ 95.1 – 100%..................☐

21. As a percentage of CREDIT sales, what do you consider the maximum acceptable percentage lost on bad debts?

Under 1% ....☐ 4.01 – 6% ....☐
1.01 – 2% ....☐ 6% and over...................☐ [Tick box]
2.01 – 4% ....☐
Other, please state ____________________________

22. Is it your policy to reassess the creditworthiness of contractors?

Yes..☐ [Tick box(es)]
No...☐ If No go to question 23.

If yes, at what intervals?

Weekly ....☐
Monthly..☐
Quarterly ....☐
Half yearly..☐
Yearly...☐
If and when the need arises ....☐
Never..☐

23. What would be the reasons for reassessing contractor creditworthiness?

If payments have slowed down ....☐
If contractor's turnover has increased dramatically..................☐ [Tick box(es)]
If contractor under new management......................................☐
If economy in a recession...☐

24. If a contractor placed a substantial order would your organisation ask for guarantees of payment?

Yes..........................☐ Sometimes............☐ [Tick box]
No............................☐

25. Do you consider your present creditworthiness evaluation procedure to be acceptable?

Yes..........................☐ Do not know ....☐ [Tick box]
No............................☐

26. Would your organisation consider providing (in confidence) data on contractors payment behaviour for materials on credit?

Yes..........................☐ [Tick box]
No............................☐

If yes, please give your details below. If your organisation wishes to submit this questionnaire and remain anonymous please offer your interest in this research by way of separate letter.

Organisation name: ____
Contact name: ____
Address: ____
____
____
Telephone number: ____________________ Fax number: ______________
E-mail: ____

All returned questionnaires will be treated in the strictest of confidence.

Thank you for completing this questionnaire.

Please return the questionnaire (and any other correspondence) to: John Nicholas, Built Environment Research Unit, University of Wolverhampton, West Midlands. WV1 1SB.

Appendix 6.2
Accompanying Letter to Targeted Pilot Materials Suppliers

THIS WAS ON LETTER HEADED PAPER

Dear Sir / Madam,

The Built Environment Research Unit at the University of Wolverhampton is presently carrying out research into the evaluation of risk to materials suppliers, when considering contractors' creditworthiness. As a first step towards a structured nation-wide independent survey of contractors' creditworthiness we have developed a 'pilot' questionnaire, covering letter and brief overview of the research. We would be grateful for your assistance in answering and indeed assessing this 'pilot' questionnaire and associated literature, adding comments and observations where appropriate that may aid in the development and refinement of the 'final' documents.

I would be grateful if you could return the completed documents by Monday 27 April 1998. A stamped addressed envelope is enclosed.

In hesitation of your assistance, thank you.

Yours faithfully,

John Nicholas (Doctoral Research Student).

Appendix 6.3
Letter and Accompanying Brief to Suppliers Targeted by Questionnaire

THIS WAS ON LETTER HEADED PAPER

For the attention of the Credit Control Manager

XY Materials Suppliers

00 Wolverhampton Road

Wolverhampton

WW1 WW2

23 February 1998

Dear Sir / Madam

The Built Environment Research Unit at the University of Wolverhampton is presently carrying out research into the evaluation of risk to materials suppliers, when considering contractors' creditworthiness. It has been identified that generally, present methods of evaluation could be improved upon. Subsequently, it would seem that creditworthiness evaluation can sometimes allow unacceptably high levels of risk for crediting organisations.

To address this issue, your co-operation in kind is welcomed by completing and returning the enclosed questionnaire. The survey will facilitate identification of key influencing factors in minimising bad debt to crediting organisations. From identification of these factors a model will be developed to calculate contractors' creditworthiness with greater accuracy than is presently the case.

We would point out that all information will be treated in strict confidence. Further, by taking part in this research your organisation will be given open access to all of the research findings.

An overview of the research is enclosed. It details the reasons and the aims of the research and advantages for organisations completing and returning the questionnaire.

It would be helpful if you could return your questionnaire as soon as possible. Please do not hesitate to contact me with any queries. Alternatively, you may contact my Director of PhD studies Dr. Gary Holt on 01902 322263.

Yours faithfully,

John Nicholas (Doctoral Research Student).

Overview of Research Project: Evaluating Contractors' Creditworthiness

The UK construction industry, when considered with peripheral inputs such as materials suppliers, manufacturers etc., accounts for approximately ten per cent of GDP. This high volume of trade inevitably carries with it varying degrees of risk. In that construction work is an amalgam of the four 'm's (men, money, machinery, materials); there is a need for accurate methods of assessing risk for those companies (particularly suppliers) considering business interaction with any other construction organisation. Surprisingly, in terms of suppliers being able to assess potential debtors' creditworthiness, this is not always the case. Further, academic research in the field of potential (construction) debtor assessment is scarce also. Research at the Built Environment Unit, University of Wolverhampton, is addressing this situation.

To date, a literature review has suggested that methods for assessing contractors' creditworthiness utilise bespoke principles and 'ad hoc' procedures. Furthermore, most assessment models in this respect fail to consider the cyclical nature of the construction industry (and the UK economy), or the dynamic management theories utilised in today's modern construction environment.

Financial risk (exposure) to any institute offering credit to construction contractors is arguably high. Hence, there is a need for a macro model(s) to be developed, with an ability to evaluate holistically the present and future creditworthiness of potential debting construction contractors. This research aims to design such a model for 'everyday' use by materials suppliers; to consider contractors' credit suitability, their future ability to repay debt and take account of the management philosophy of 'financial reimbursement for credit terms utilised' i.e. wait until court proceedings are threatened to make payment!

By developing an accurate creditworthiness evaluation model(s) the risk element to supplier organisations will be more easily identified and hence costed.

Any organisation returning a completed questionnaire will of course be given full access to the research findings.

All returned questionnaires will be treated in strict confidence. No references will be made directly to any organisation in any future work.

John Nicholas (Doctoral Research Student)
Director of Studies: Dr. Gary D. Holt BSc (Hons), PhD, FCIOB, MASCE (USA), FFB.
Contact Details: Telephone: 01902 322263
Fax : 01902 322743
E-mail: e9671105@wlv.ac.uk (for John Nicholas)
G.D.Holt@wlv.ac.uk (for Gary Holt)

Appendix 6.4
Feedback Supplied to Materials Suppliers Participating in Survey

INVESTIGATION INTO CONSTRUCTION SUPPLIERS' DEBT COLLECTION AND CONTRACTOR CREDITWORTHINESS EVALUATION PROCEDURES

INTERIM SUMMARY AND FEEDBACK TO SURVEY RESPONDENTS

Researcher: J. Nicholas
Supervision Team: G. D. Holt (Reader in Construction Management)
P. T. Harris (Senior Lecturer)
M. Mihsein (Dean of School)

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West Midlands WV1 1SB

INVESTIGATION INTO CONSTRUCTION SUPPLIERS' DEBT COLLECTION AND CONTRACTOR CREDITWORTHINESS EVALUATION PROCEDURES

INTRODUCTION

Results on the first ever survey of UK materials suppliers' credit control and debt collection procedures are presented. The survey was undertaken during August 1998, as part of an initial investigation for a PhD research programme into the risk associated with granting construction contractors credit facilities. The analyses performed upon responding suppliers' data identified key methods and trends associated with: construction contractor creditworthiness evaluation; suppliers' methods of debt collection; and the efficiency, or otherwise, of these techniques. Responses identified a number of surprising results, including the minimal amount of resources consumed on evaluating potential debtors, the questionable methods by which credit limits are established, and the minimal use of insurance and factoring for protection against bad debt. Responses highlight that construction contractor creditworthiness evaluation and debt collection procedures are typically bespoke, ad-hoc and have received minimal research to date.

SUMMARY OF RESULTS

- Of 375 questionnaires dispatched a total of 55 were returned completed: a response rate of 15 per cent.

Supplier Characteristics

- Respondent materials suppliers furnish goods on credit to a wide spectrum of construction trades (Table 1).

Table 1. Suppliers: Customer Base by Contractor Activity Classification.

Contractor Classification	*Number of Materials Suppliers Interacting with Classification of Contractor*	*Percentage of Materials Suppliers Interacting with Classification of Contractor*
Roofing and Insulation	33	19.30
Plumbing, heating and ventilation	29	16.96
Electrical	10	5.85
Ground work	27	15.79
General building	40	23.39
Painting and decorating	22	12.87
Specialist	4	2.34
Other	6	3.51
TOTALS	***171***	***100.00***

- Table 2 shows that the sample captured a large cumulative amount of all construction materials suppliers' trade. Based on the median value for each turnover category given in Table 2, and taking £25m as optimum turnover for the final category; respondents' total turnover is conservatively estimated at £466.25m.

Sales Turnover

- Average respondent percentage turnover growth for the periods 1995-6, 1996-7 and 1997-8 was 3.58, 6.10 and 7.88 per cent respectively.

- Respondents reporting annual turnover contraction reduced in number from 11 suppliers in 1995-6, to five in 1996-7 and four in 1997-8.

Table 2. Suppliers' Financial Turnover Characteristics.

Turnover	*Number of Materials Suppliers*	*Percentage of Materials Suppliers*	*Cumulative Percentage of Materials Suppliers*
Up to £½ million	2	3.70	3.70
Over £½ and under £1million	7	12.96	16.66
Over £1 million and under £2 million	5	9.26	25.92
Over £2 million and under £6 million	20	37.04	62.96
Over £6 million and under £12 million	6	11.11	74.07
Over £12 million and under £16 million	2	3.70	77.77
Over £16 million and under £25 million	2	3.70	81.47
Over £25 million	10	18.52	100.00
TOTALS	***54***	***100.00***	***100.00***

Number of Credit Accounts

- One-third (18) of respondents had over 1,001 credit accounts (Table 3).
- For each contractor serviced, this credit ranged from approximately £1,800 to over £25 thousand per year.

Table 3. Number of Credit Accounts.

Number of Credit Accounts	*Number of Credit Accounts Materials Suppliers Offered to Contractors*	*Percentage of Credit Accounts Materials Suppliers Offered to Contractors*	*Cumulative Percentage of Credit Accounts Materials Suppliers Offered to Contractors*
1 – 50	0	0.00	0.00
51 – 100	4	7.41	7.41
101 – 300	9	16.67	24.08
301 – 500	10	18.52	42.60
501 – 1,000	13	24.07	66.67
1,001 and over	18	33.33	100.00
TOTALS	***54***	***100.00***	***100.00***

Credit Sales to Turnover Ratio

- On a cumulative percentage basis, more than 60 per cent of respondents' credit sales accounted for over 70 per cent of their turnover (Table 4).

Table 4. Suppliers Proportion of Credit Sales to Turnover.

Proportion of Turnover to Credit Sales	*Number of Materials Suppliers*	*Percentage of Materials Suppliers*	*Cumulative Percentage of Materials Suppliers*
30.1 – 40%	4	7.69	7.69
40.1 – 50%	4	7.69	15.38
50.1 – 60%	6	11.54	26.92
60.1 – 70%	6	11.54	38.46
70.1 – 80%	12	23.08	61.54
80.1 – 90%	17	32.69	94.23
90.1 – 100%	3	5.77	100.00
TOTALS	***52***	***100.00***	***100.00***

Analysing Creditworthiness

- Over 80 per cent of respondents always checked the creditworthiness of contractors before offering credit facilities.
- Reasons cited for conducting a creditworthiness check on a '*sometimes*' basis included:
    - *only if the credit amount required is in excess of one thousand pounds;*
    - *only if the organisation is unknown to the supplier; and*
    - *only if 'deemed' necessary e.g. for new companies who do not have a previous credit track record.*

Credit Limit Imposition

- Credit limits were imposed by over two thirds of respondents (36) on eighty to one hundred per cent of 'creditworthy' contractors (Table 5).
- Of those suppliers that only imposed limits on one to twenty per cent of their credit contractors, these tended to be smaller organisations with turnovers ≤ £2m per year.

Table 5. Credit Limit Imposition.

Credit Limits Imposed on Contractors	*Number of Responses*	*Percentage of Responses*
None	0	0.00
1 – 20%	7	13.21
20.1 – 40%	0	0.00
40.1 – 60%	3	5.66
60.1 – 80%	7	13.21
80.1 – 100%	36	67.92
TOTALS	*53*	*100.00*

Credit Limit Evaluation

- Credit registers, Bank references and the duration of the relationship between contractor and supplier were the most common sources used for determining credit limits (Table 6).

Table 6. Methods of Establishing Credit Limits.

Methods of Establishing Credit Limits	*Number of Responses*	*Percentage of Responses*
Credit Registers	27	40.30
Bank Information	14	20.90
Duration of Relationship (Between Organisations)	26	38.81
TOTALS	*67*	*100.00*

Creditworthiness Procedures

- Specific procedures for evaluating creditworthiness were numerous in nature (Table 7).
- 'Other' methods that respondents cited were 'local information about the contractor' (8 users), 'judgement and knowledge of contractors' ability to repay debts' (8 users) and six respondents asked other suppliers for their opinion as to the creditworthiness of a contractor.

Resources for Creditworthiness Analysis

- The majority of respondents (43) spend no longer than one hour on contractor creditworthiness evaluation; and a mean weighted cost of £46.93 is consumed per contractor evaluated (Table 8).
- The costs of credit control departments represented less than 0.5 per cent of turnover for half of

the sample. Credit control departments costing between 0.51 and one per cent of suppliers' turnover, represented nearly 40 per cent of responses.

Table 7. Source and Methods Used for Evaluating Creditworthiness.

Source / Method	***Number of Users***	***Percentage of Users***	***Overall Ranked Accuracy***
Altman's Z score	0	0.00	-
Altman's ZETA model	0	0.00	-
Bankers Reference	29	13.56	3
Contact with Company Concerned	26	12.15	5
Credit Registers	38	17.76	2
Report from Salesman	31	14.49	4
Ratio Analysis	8	3.74	7=
Trade Reference	47	21.96	1
Trade Protection Association	13	6.07	6
Other	22	10.28	7=
None	0	0.00	-
TOTALS	***214***	***100.00***	
Number of contributing respondents = 52			

Table 8. Resources Consumed Evaluating Each Contractor's Creditworthiness

Time Consumed	***Number of Response***	***Percentage of Responses***
0 – 1 Hour	43	79.63
1.01 – 3 Hours	8	14.81
3.01 – 6 Hours	2	3.70
6.01 – 12 Hours	0	0.00
Over 12.01 Hours	1	1.85
TOTALS	***54***	***100.00***
Finances Consumed	***Number of Responses***	***Percentage of Responses***
Under £20	24	44.44
£21 - £50	23	42.59
£51 – 100	3	5.56
£101 - £200	1	1.85
£201- £400	1	1.85
Over £400	2	3.70
TOTALS	***54***	***100.00***

Terms Of Payment

- The majority of respondents (36) allow credit until the end of the month after delivery. Some (12) offered thirty days credit. Only one supplier made sixty-day accounts available, this facility only being available to certain contractors (Table 9).
- The majority (33) do not offer discounts for prompt payment. Of those respondents who do offer discounts, 94 per cent of them give two and a half per cent for settlement by the end of the month; and one supplier offered the incentive of five per cent discount if payment is received by the fifteenth day of the month.

Table 9. Suppliers Standard Terms of Payment and Discounts for Prompt Payment.

Terms Offered	***Number of Responses***	***Percentage of Responses***
Thirty days	12	22.64
End of month after delivery	36	67.92
End of month of delivery	5	9.43
TOTALS	***53***	***100.00***
Discounts Offered	***Number of Responses***	***Percentage of Responses***
Yes	17	34.00
No	33	66.00
TOTALS	***50***	***100.00***

Suppliers' Financial Characteristics

- The majority of respondents (43) incurred less than one per cent (of turnover) bad debt in the financial year 1997-8 (Table 10).
- Nearly fifteen per cent of respondents (8) admitted to bad debt accounting for between 1.01 and 2 per cent of turnover.

Table 10. Bad Debt to Sales.

Bad Debt To Sales	*Number of Responses*	*Percentage of Responses*
Under 1%	43	79.63
1.01 and under 2%	8	14.81
2.01 and under 3%	2	3.70
3.01 and under 4%	0	0.00
4.01 and under 5%	0	0.00
5.01 and over	1	1.85
TOTALS	*54*	***100.00***

Suppliers' Targeted Profit Margin

- When asked what profit margin is sought before bad debt is considered, a spread of answers is supplied (Table 11).
- The modal profit margin amongst the sample was fifteen per cent and over.

Table 11. Targeted Profit Margins.

Targeted Profit Margin Before Bad Debt Implications	*Number of Responses*	*Percentage of Responses*
Under 2%	4	8.51
2.01 – 4%	7	14.89
4.01 – 6%	9	19.15
6.01 – 8%	4	8.51
8.01 – 10%	4	8.51
10.01 – 12.5%	4	8.51
12.51 – 15%	0	0.00
15% and over	15	31.91
TOTALS	*47*	***100.00***

Collection of Overdue Accounts

- The majority of respondents (50) have a standard procedure for collecting overdue accounts.
- Reminding letters are by far the most used procedure. However, contractors' responses to these only tend to be 'average' (Table 12).
- Trade protection associations are identified as the optimal method for collection of overdue accounts by two respondents. Visits by the supplier's credit department personnel also seem to have good responses for debt collection purposes.
- The more 'formal' collection methods (summons issued by solicitors and court action) seem to offer a response not greater than 'average'.

Insurance and Factoring

- Only six respondents took out insurance to offset bad debt. Of those that did, the type of policy most used was a whole turnover policy (5). The turnover policies used by suppliers varied in the percentage of debt that they could claim for. Only one supplier used factoring (Table 13).

Table 12. Collection Procedures.

Standard Procedure for Collection of Overdue Accounts	***Number of Responses***	***Percentage of Responses***
Yes	50	92.59
No	4	7.41
TOTALS	***54***	***100.00***

Procedure Used	***Number of Suppliers taking Action***	***Average Number of Times Used Per Year***	***After how many days overdue (Average)***	***Debtor's Response (Average)***		
				Good	*Average*	*Poor*
Further statements	25	450.00	10.60	2 (9.52)	16 (76.19)	3 (14.29)
Reminding Letter	47	1405.00	16.74	17 (40.48)	24 (57.14)	1 (2.38)
Contact by salesman	28	209.00	14.86	13 (50.00)	11 (42.31)	2 (7.69)
Telephoned by Credit Dept.	42	567.00	18.17	26 (63.42)	14 (34.15)	1 (2.43)
Visited by Credit Dept.	9	29.00	26.00	5 (71.43)	2 (28.57)	0 (0.00)
Account taken to collection agency	17	48.00	27.11	8 (50.00)	6 (37.50)	2 (12.50)
Trade protection association intervention	2	2.50	30.00	2 (100.00)	0 (0.00)	0 (0.00)
Summons issued by credit section	15	16.47	41.47	9 (69.23)	3 (23.08)	1 (7.69)
Summons issued by legal department	6	21.00	38.17	2 (50.00)	2 (50.00)	0 (0.00)
Summons issued by solicitor	30	12.80	44.13	12 (46.15)	10 (38.46)	4 (15.38)
Court action	30	6.43	51.07	13 (46.43)	9 (32.14)	6 (21.43)

Figures in parenthesis indicate percentage observations.

Table 13. Insurance and Factoring against Bad Debt Statistics.

Insurance Against Bad Debt	***Number of Responses***	***Percentage of Responses***
Yes	6	11.11
No	48	88.89
TOTALS	***54***	***100.00***
If insurance policy used		
Type of Policy	***Number of Responses***	***Percentage of Responses***
Specific Debt	1	16.67
Whole turnover policy	5	83.33
TOTALS	***6***	***100.00***
If whole turnover policy used, percentage of debt insured against		
Type of Policy	***Number of Responses***	***Percentage of Responses***
Under 75%	1	20.00
75.1 – 85%	1	20.00
85.1 – 95%	2	40.00
95.1 – 100%	1	20.00
TOTALS	***5***	***100.00***
Factor Against Bad Debt	***Number of Responses***	***Percentage of Responses***
Yes	1	1.85
No	53	98.15
TOTALS	***54***	***100.00***
If Factor policy used		
Type of Policy	***Number of Responses***	***Percentage of Responses***
Under 75%	0	0.00
75.1 – 85%	1	100.00
85.1 – 95%	0	0.00
95.1 – 100%	0	0.00
TOTALS	***1***	***100.00***

Acceptable Bad Debt

- The amount of bad debt considered 'acceptable' was below one per cent of turnover for the majority of respondents (40) (Table 14). Twelve suppliers stated that bad debt could account for between one and two per cent.

Table 14. Acceptable Bad Debt on Credit Sales.

Acceptable Bad Debt	*Number of Responses*	*Percentage of Responses*
Under 1%	40	75.47
1.01 – 2%	12	22.64
2.01 – 4%	1	1.89
4.01 – 6%	0	0.00
6% and over	0	0.00
TOTALS	***53***	***100.00***

Creditworthiness Reassessment

- Over eighty-five per cent of respondents reassess contractor creditworthiness (Table 15).
- Only 16 respondents stated that they would reassess the creditworthiness of contractors when the economy was in recession in addition to the re-evaluation policy that they already operated.
- The majority reassessed creditworthiness when changes in contractors' characteristics occur (such as slowing down of payments, an increase in contractor turnover and the contractor being under new management).
- Twenty-two respondents who do not reassess in times of recession and only reassess on an *'if and when the need arises basis'* all considered changes in contractor characteristics as sufficiently important to carry out a reassessment.
- Table 15 shows that over one quarter of respondents (14) would not ask for guarantees of payment if a contractor placed a 'substantial' order.

Table 15. Creditworthiness Reassessment Policy and Guarantees for Substantial Order

Reassessment	***Number of Responses***	***Percentage of Responses***
Yes	47	87.03
No	7	12.93
TOTALS	***54***	***100.00***
Reassessment Intervals	***Number of Responses***	***Percentage of Responses***
Weekly	2	3.33
Monthly	1	1.67
Quarterly	2	3.33
Half Yearly	5	8.33
Yearly	10	16.67
If and when the need arises	40	66.67
Never	0	0.00
TOTALS	*60*	*100.00*
Reason For Reassessment	***Number of Responses***	***Percentage of Responses***
Payments slowed down	46	30.67
Contractor's turnover increased dramatically	49	32.67
Contractor under new management	39	26.00
Economy in recession	16	10.67
TOTALS	***150***	***100.00***
Substantial Order Placed; Guarantee Asked For	***Number of Responses***	***Percentage of Responses***
Yes	10	18.52
No	14	25.93
Sometimes	30	55.56
TOTALS	***54***	***100.00***

Appendix 8.1
Discriminant factors associated with predicting suppliers' turnover

Code	*Description*	*Factor*
Q3N	Supplier turnover up to £ ½ m per annum	1
	Supplier turnover over £½m per annum and under £1m	2
	Supplier turnover over £1m per annum and under £2m	3
	Supplier turnover over £2m per annum and under £6m	4
	Supplier turnover over £6m per annum and under £12m	5
	Supplier turnover over £12m per annum and under £16m	6
	Supplier turnover over £16m per annum and under £25m	7
	Supplier turnover over £25m per annum and over	8
Q19N	Supplier does not insure against bad debt	1
	Supplier does insure against bad debt	2
Q5N	Supplier furnished 1–50 credit accounts in last financial year (1997-8)	1
	Supplier furnished 51–100 credit accounts in last financial year (1997-8)	2
	Supplier furnished 101–300 credit accounts in last financial year (1997-8)	3
	Supplier furnished 301–500 credit accounts in last financial year (1997-8)	4
	Supplier furnished 501–1,000 credit accounts in last financial year (1997-8)	5
	Supplier furnished 1,000 and over credit accounts in last financial year (1997-8)	6
Q5O	Supplier furnished 1–50 credit accounts in last financial year (1997-8)	25
	Supplier furnished 51–100 credit accounts in last financial year (1997-8)	75
	Supplier furnished 101–300 credit accounts in last financial year (1997-8)	200
	Supplier furnished 301–500 credit accounts in last financial year (1997-8)	400
	Supplier furnished 501–1,000 credit accounts in last financial year (1997-8)	750
	Supplier furnished 1,000 and over credit accounts in last financial year (1997-8)	1,000
Q8N	Percentage of creditworthy contractors suppliers' impose credit limits on: None	1
	Percentage of creditworthy contractors suppliers' impose credit limits on: 1-20%	2
	Percentage of creditworthy contractors suppliers' impose credit limits on: 21-40%	3
	Percentage of creditworthy contractors suppliers' impose credit limits on: 41-60%	4
	Percentage of creditworthy contractors suppliers' impose credit limits on: 61-80%	5
	Percentage of creditworthy contractors suppliers' impose credit limits on: 81-100%	6
ZQ24N	Supplier would never ask for guarantees of payment if a contractor placed a substantial order	-1.385
	Supplier would sometimes ask for guarantees of payment if a contractor placed a substantial order	0.111
	Supplier would always ask for guarantees of payment if a contractor placed a substantial order	1.606
ZQ4N	Negative financial turnover contraction over last three years	-2.150
	Financial turnover sterility over last three years	-0.888
	Positive financial turnover contraction over last three years	0.374

ZQ4N calculated using 1995-6, 1996-7, and 1997-8's financial turnover growth / contraction figures. For example, an organisation with five per cent growth in 1995-6, eight per cent contraction in 1996-7, and two per cent growth in 1997-8's would be classified as having growth characteristics (1.05 x 0.92 x 1.02 = 1.0135). Inflation has been ignored for this factor.

Appendix 8.2
Discriminant factors associated with suppliers' turnover movement

Discriminant Factors		
Classification Category		***Factor***
Q19N	Supplier does not insure against bad debt	1
	Supplier insures against bad debt	2
Q1N	Supplier supplies materials to roofing and insulation contractors	1
	Supplier supplies materials to plumbing, heating and ventilation contractors	2
	Supplier supplies materials to electrical contractors	3
	Supplier supplies materials to ground work contractors	4
	Supplier supplies materials to general building contractors	5
	Supplier supplies materials to painting and decorating contractors	6
	Supplier supplies materials to specialist contractors (e.g. acoustic engineers, lift engineers etc.)	7
	Supplier supplies materials to two or more of the above trades	8
Q9N	Supplier uses credit registers to define credit limits for each contractor	1
	Supplier uses Bank supplied information to define credit limits for each contractor	2
	Supplier uses duration of supplier / contractor relationship define credit limits for each contractor	3
	Supplier uses two or more of the above methods for defining credit limits	4
Q2N	Supplier supplies materials to contractors on a Nation-wide basis	1
	Supplier supplies materials to contractors in Scotland	2
	Supplier supplies materials to contractors in Ireland	3
	Supplier supplies materials to contractors in Wales	4
	Supplier supplies materials to contractors in the South West of England	5
	Supplier supplies materials to contractors in the Home Counties of England	6
	Supplier supplies materials to contractors in the Midlands	7
	Supplier supplies materials to contractors in the North East of England	8
	Supplier supplies materials to contractors in the North West of England	9
	Supplier supplies materials to contractors in the East of England	10
Q21O	Supplier's maximum acceptable bad debt to credit sales: Under 1 %	0.005
	Supplier's maximum acceptable bad debt to credit sales: 1.01 to 2 %	0.015
	Supplier's maximum acceptable bad debt to credit sales: 2.01 to 4 %	0.030
	Supplier's maximum acceptable bad debt to credit sales: 4.01 to 6 %	0.050
	Supplier's maximum acceptable bad debt to credit sales: 6 % and over	0.060
Q11N	Average time supplier spends evaluating each contractors' creditworthiness:	
	under 1 hour	1
	1.01 to 3 hours	2
	3.01 to 6 hours	3
	6.01 to 12 hours	4
	12.01 hours and over	5
Q13N	Percentage turnover per annum suppliers' credit control department costs to run:	
	Under 0.5 %	1
	0.51 to 1 %	2
	0.01 to 2 %	3
	2.01 to 3 %	4
	3.01 to 4 %	5
	4.01 to 5 %	6
	5.01% and over	7
Q14N	Suppliers' standard terms of payment:	
	Thirty days	1
	End of month after delivery	2
	End of month of delivery	3

Q16O	Suppliers' percentage of bad debt to sales in last financial year (1997-8):	
	Under 1 %	0.005
	1.01 to 2 %	0.015
	2.01 to 3 %	0.025
	3.01 to 4 %	0.035
	4.01 to 5 %	0.045
	5% and over	0.050

Appendix 8.3.
Discriminant factors associated with suppliers' bad debt

Code	Description	Factor
Q18N	Supplier does not have a standard procedure for collecting overdue accounts	1
	Supplier has a standard procedure for collecting overdue accounts	2
Q7N	Supplier never checks on the creditworthiness of contractors before granting them credit	1
	Supplier sometimes checks on the creditworthiness of contractors before granting them credit	2
	Supplier always checks on the creditworthiness of contractors before granting them credit	3
Q14N	Suppliers' standard terms of payment: thirty days	1
	Suppliers' standard terms of payment: end of month after delivery	2
	Suppliers' standard terms of payment: end of month of delivery	3
Q19N	Supplier does not insure against bad debt	1
	Supplier does insure against bad debt	2
Q24N	Supplier would not ask for guarantees of payment if substantial order placed	1
	Supplier would sometimes ask for guarantees of payment if substantial order placed	2
	Supplier would always ask for guarantees of payment if substantial order placed	3
Q4N	Supplier had overall contraction in sales turnover from 1995 - 1998	1
	Supplier had no movement in sales turnover from 1995 - 1998	2
	Supplier had overall growth in sales turnover from 1995 - 1998	3
Q9N	Supplier uses credit registers to establish credit limits for each contractor	1
	Supplier uses Bank supplied information to establish credit limits for each contractor	2
	Supplier evaluates credit limits for each contractor based on the duration of relationship between the organisations	3
	Supplier uses two or more of the above methods to establish credit limits for each contractor	4

Appendix 8.4

Discriminant factors associated with predicting suppliers' profit margins

Code	Description	Factor
Q24N	Supplier would never ask for guarantees of payment if contractor placed substantial order	1
	Supplier would sometimes ask for guarantees of payment if contractor placed substantial order	2
	Supplier would always ask for guarantees of payment if contractor placed substantial order	3
Q3N	Supplier financial turnover up to £½ million	1
	Supplier financial turnover £½ million and under £1m	2
	Supplier financial turnover £1 million and under £2m	3
	Supplier financial turnover £2 million and under £6m	4
	Supplier financial turnover £6 million and under £12m	5
	Supplier financial turnover £12 million and under £16m	6
	Supplier financial turnover £16 million and under £25m	7
	Supplier financial turnover £25 million and over	8
Q5N	Number of credit accounts furnished 1 – 50	1
	Number of credit accounts furnished 51 – 100	2
	Number of credit accounts furnished 101 – 300	3
	Number of credit accounts furnished 301 – 500	4
	Number of credit accounts furnished 501 – 1,000	5
	Number of credit accounts furnished 1,001 and over	6
Q9N	Establish credit limits using credit registers	1
	Establish credit limits using bank supplied information	2
	Establish credit limits based on duration of relationship	3
	Establish credit limits using two or more of the above methods	4
Q13N	Percentage of turnover credit control department costs. Under 0.5 per cent	1
	Percentage of turnover credit control department costs. 0.51 – 1.00 per cent	2
	Percentage of turnover credit control department costs. 1.01 – 2.00 per cent	3
	Percentage of turnover credit control department costs. 2.01 – 3.00 per cent	4
	Percentage of turnover credit control department costs. 3.01 – 4.00 per cent	5
	Percentage of turnover credit control department costs. 4.01 – 5.00 per cent	6
	Percentage of turnover credit control department costs. 5.01 per cent and over	7
Q2N	Materials are supplied on a Nation-wide basis	1
	Materials are supplied to Scotland	2
	Materials are supplied to Ireland	3
	Materials are supplied to Wales	4
	Materials are supplied to the South West of England	5
	Materials are supplied to the Home Counties	6
	Materials are supplied to the Midlands	7
	Materials are supplied to the North East	8
	Materials are supplied to the North West	9
	Materials are supplied to the East	10
Q12O	Amount supplier spends evaluating a contractor's creditworthiness <£20	10
	Amount supplier spends evaluating a contractor's creditworthiness £21-£50	35
	Amount supplier spends evaluating a contractor's creditworthiness £51-£100	75
	Amount supplier spends evaluating a contractor's creditworthiness £101-£200	150
	Amount supplier spends evaluating a contractor's creditworthiness £201-£400	300
	Amount supplier spends evaluating a contractor's creditworthiness over £400	400
Q4EQ LSZ	Percentage growth / contraction in sales turnover the supplier has experienced over financial years 1995-6, 1996-7 and 1997-8 (1 denotes constant):	
	0.56 to 104	1
	104.1 to 112.0	2
	112.1 to 118.0	3
	118.1 to 133.0	4
	133.1 to 172.0	5

Q9N	Method used for establishing credit limits: credit registers	1
	Method used for establishing credit limits: Bank supplied information	2
	Method used for establishing credit limits: Based on duration of relationship between supplier and contractor	3
	Two or more of the above methods	4